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Introductory map of Green Business Opportunities

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Summary

The ambition of the SSL-erate Green Business Development is to accelerate deployment of SSL, which is considered to have great potential from sustainable development point of view. One aim for the "green" sustainability oriented transformation is to promote solutions that have a higher positive social effect, e.g. by enabling better living environments in preschools, schools and for elderly people. Another main aim is to promote green investments, i.e. sustainability oriented investments and thereby green jobs.

This report gives an intelligent "Green Business Development" perspective, where the adjective "intelligent" describes a conceptual connection to intelligent system solutions and intelligent ways of integrating sustainability considerations in the core of the value-creating business development.

The Lund workshop on the potential of Green Business Development for SSL has shown that cities across Europe want to initiate pilot and demonstration projects for sustainability lighting solutions. The goal is to achieve a significantly higher added value by human-centric solutions. A rich set of case studies on demonstration projects reports on solutions that offer on average 59% energy savings. Moreover, some of these studies report that the new solutions provide significantly better lighting, i.e. higher added value, which we interpret as the most interesting result. However, the information about the improvement potential is rarely quantified and there is limited general awareness about the human value of dynamic lighting. From an intelligent green business development point of view it is crucial to clarify the added value potential, to make it attractive to invest in intelligent solutions and more advanced SSL. There is a solid foundation of knowledge and experience about the potential of advanced integrated forms of green business development. However, public procurement tends to go for lowest cost and the mainstream energy saving projects tend to be rather primitive from a user value point of view. The ambitions that are articulated by the ENIGMA cities largely aim for a higher user value, i.e. an enhancement of the social sustainability value of intelligent deployment of SSL.

Intelligent green business development can make use of the still untapped potential to close the gap between the users' needs and desires (of which they may be unaware) and the technical potential. One challenge is that potential customers are hesitant to procure a new kind of solutions as long as the higher values are not measured or proven, or at least made clearer than today. Risk-sharing as well as political leadership can help to overcome this barrier in order to make first experiences with visible pilot projects as inspiration for deployment and further development. To enhance the interest in a green venture it may be useful to consider various kinds of co-branding effects. Honesty and openness are crucial to build a common ground and trust.

To be able to significantly enhance the level of customer value it is vital to get going with test-bed installations of more advanced lighting and living lab activities as a base for mutual learning. This involves a meeting of minds between the suppliers and the users perspectives. To be able to accelerate deployment of sustainable SSL solutions, the SSL-erate project suggests collaboration in an open innovation process.

The observations regarding the social value of attractive lighting and functional system solutions illustrate that it is vital to elucidate the value enhancing aspects. Furthermore, it is crucial to avoid that primitive cost minimization and energy savings lead to unattractive lighting solutions. The technology of today offer enormous flexibility and it is crucial to deploy it in a wise way.

Advice to the reader

This SSL-erate deliverable presents a mapping of positive green business development examples and guidance for intelligent green business development, aiming to stimulate green investments in development and demonstration of value enhancing SSL applications.

One topical reason for the use of “Green” as a heading for the intended SSL investments is that numerous actors in Europe have allocated quite a lot of public and company money for energy saving projects and green investments. Furthermore, numerous political stakeholders display significant prestigious green development ambitions.

One goal for this mapping is to enable the project partners to make more future-oriented use of the funding possibilities for user driven innovation oriented procurement and energy saving projects. In this respect “intelligent” means solutions that will be appreciated as more attractive and more sustainable, both at present and after using those solutions quite some time.

This report is one delivery of and tool for the SSL-erate project:

“The aim of SSL-erate is to accelerate the uptake of high-quality SSL technology in Europe by means of open innovation and by bringing validated information to all relevant stakeholders. A coordinated European effort is required to address the European societal challenges (in particular health & quality of life in an ageing society, energy consumption and resource efficiency), to resolve the specific challenges of the Lighting industry as noted in the results of the Green Paper “Lighting the Future” consultation (notably: poor SSL quality, lack of information and awareness among citizens) and to enable lighting solutions with a societal and environmental sustainability perspective, leading to a future in which Europe evolves to the global leadership in SSL systems and solutions. The lighting industry is highly fragmented. As a consequence of this the innovation speed and success rate have been too low and the benefits that we all expect from better lighting solutions, do not sufficiently materialize. To overcome this fragmentation, a collaborative way-of-working, using open-innovation and smart specialization principles, will be taken as the guiding approach. The active involvement of various stakeholders will be realized through workshops, but also through the creation of a web-based SSL-erate Innovation platform, which is planned to continue beyond the duration of this project. Relevant (lighting and non-lighting) companies, but also other stakeholders (like public authorities, property owners, research institutes, (lead) users/citizens, entrepreneurs, architects, installers) will become active contributors to this accelerated innovation process by applying validated insights on ‘green business development’ and ‘lighting effects on health & well-being’ in SSL-erate business experiments.”

DoW abstract

It is a basic project ambition to promote development and deployment of solutions that become more and more attractive, so that they can attract increasing political support and can take market shares from less sustainable solutions. One key SSL-erate concern is to promote SSL solutions for better health and wellbeing. When such improvement possibilities are shown it becomes a societal social responsibility, SSR, analogous to Corporate Social Responsibility, CSR, to take action to make improvements.

In Europe today there is a lot of political support for innovation promoting procurement and energy saving investments. It is crucial that those investments are made in such a way that the resources available are mobilized to promote a sustainable development by means of attractive solutions. One dimension is to aim for synergies between social, economic and environmental improvements. One other well-known aim for sustainable development is to meet the needs of the present without compromising the ability of future generations to meet their own needs. Furthermore, already the Brundtland report clarified that:

Sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technical development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations...
(WCED, 1987)

One challenge here is that we have limited knowledge about the future needs and desires, in particular during radical changes in technology and knowledge. At present, it is obvious that the lighting products and system solutions are changing very rapidly. The old lighting products have been prohibited and ever more LED lamps appear. It is obvious that it is possible to save energy with smart lighting systems. The SSL and ICT of today enable a lot of flexibility to build lighting systems that provide the right light, at the right place, at the right time, for each and everyone. However, there is quite a bit of uncertainty about which kinds of light characteristics, dynamics and system functionalities we ought to aim for.

Nearly all assessments of light so far have been made for the static electric lighting that we have become accustomed to. Furthermore, the light from most of the LED smart lighting so far is rather static. Consequently, most people find it difficult to understand the advantages of dynamic light.

The magnitude of the human improvement potential with new forms advanced dynamic lighting systems is indicated by the following experiment of thought:

The latest hundred years, humans in industrialized societies have become accustomed to static, somewhat reddish, slightly flickering light environments where we essentially have been aiming for more lumens and the same light everywhere, all the time. However, the human sensory system is adapted to the varying light in nature, where the colour composition, the proportion of directional light and the intensity vary quite a lot. We know that sometimes we want functional light and sometimes we want cozy light, and also darkness. We know that the glittering light from moving water and in the forest feels good, many appreciate the play of light at sunrise and sunset, and we appreciate candlelight dinners.

To enable appropriate value-enhancing improvements it is crucial to open up for a sustainable process of change, i.e. innovation and open-minded multidisciplinary learning about new challenges and new opportunities. This report presents the concept "Intelligent Green Business Development" as a name for the kind of approach that WP2 is aiming for.

Q & A Green Business Development

The SSL-erate definition of Green Business Development:

Intelligent Green Business Development aims to facilitate deployment of sustainable solutions, by development and deployment of intelligent SSL-based system solutions that become ever more attractive for users, customers, societal actors and businesses.

Why is it so important to clarify the positive side of the Green dimension of SSL ?

- A large part of the so-called green initiatives so far are rather delimited to the energy saving itself. Furthermore, public procurement normally focuses on the cost and the cheapest ways to save energy tend to be rather primitive. Such primeval solutions are not likely to provide the best lighting and system functionality. Consequently, the energy saving solutions risks to become unpopular, see chapter 2.2.

What is the main advantage of the SSL-erate Green Business Development framing?

- In Europe, today, there is a lot of interest in and resources for energy saving investments and innovation promoting procurement. Our framing can be used to clarify why it is so crucial to use these societal resources for sufficiently intelligent investments.
- This is one opening to promote development of the Knowledge Society, i.e. a society with ability to make ever more advanced combined use of various kinds of knowledge. By using this framing we can develop and describe the advantages of thoughtful solutions. This is vital for the labor market for all kinds of “knowledgeable workers”.
- Investments that promote renewal, local adaptation and systemic functionality will generate a lot of green jobs.

What to answer when people say that the actual meaning of Green Business Development is to reduce the environmental load?

- This is a very common perception, but only part of the picture. In our understanding Green Business Development should not neglect, but rather emphasise the social and economic sustainability aspects.
- Furthermore, Green Business Development is one kind of Business Development. SSL-erate has a market-based perspective and aims to promote business development for Intelligent SSL-based solutions, i.e. for a green technology. In this three-word concept the social value-enhancement is part of the basis in “Business” dimension.
- The basic principle of SSL is energy efficient so the key green business question is how to accelerate more intelligent deployment of this sustainability advantage.

Which areas are interesting for Green SSL investments?

- Considering the social dimension of sustainability: Intelligent SSL-based Lighting can be used for improvement of the working and living conditions in preschools, schools, offices and other work places, restaurants, sports facilities and other (re-)habilitative environments, not least for elderly people. Urban applications for public buildings, traffic

and street lighting have a high potential for solution to increase safety and security through way indication, signal functions as well as reduced light pollution and beautification.

- Furthermore the CSR (Corporate Social Responsibility) argument and also the Societal Social Responsibility argument can be used to promote investments in enhancement of the lighting aspects of the working conditions.

Which stakeholders can take advantage from engagement in the SSL-erate advanced Green Businesses Development?

- All actors that aim to take a leading position in systemic utilization of SSL,
 - o to develop working and living environments by means of green solutions,
 - o to develop green business concepts for SSL, smart buildings and smart cities.
- ICT and SSL actors that aim to develop a Green profile for Advanced, Adaptive, Intelligent solutions for lighting, buildings and cities.
- Competence based businesses working with enhancement of ICT-based services, design, architecture, the building sector and facility management.

What are the main bottlenecks?

- Quality assurance in a more and more fragmented and complex market.
- Development of common metrics to measure social benefits of smart system solutions and more advanced lighting.
- The real life procurement inclination to select the cheapest products.
- Rather primitive Green Business understanding among various kinds of societal procurement and development actors.
- The principal agent dilemma, i.e. the landlord tenant conflict, which is limiting the actual interest in sound investments.
- The rapid pace of technical development means that the present products tend to become outdated rather soon. The flexibility and compatibility for upgrading is important.

What are the main opportunities?

- Create solutions with superior effectiveness, from user point of view.
- Business models will emerge from increased usability and customer value, e.g. smart systems for connected lighting.
- Using the purchasing power of cities to influence the solution providers from the demand side.
- Smart System solutions will open up for new value chain structures and new business models.
- The great potential to develop ever more intelligent solutions, e.g. supported by apps, will open up for service based business development.

1 Introduction

The ambition of the SSL-erate Green Business Development is to accelerate the deployment of SSL, which is considered to have great potential from sustainable development point of view. We are using a sustainable development framing that aims to combine social and economic progress and environmental improvements. One main aim is to promote solutions that have a positive social effect, e.g by enabling better living environments in preschools, schools and for elderly people. Another main aim is to promote green investments, i.e. sustainability oriented investments and thereby green jobs.

One basis for this line of thinking is that already LED in itself is an energy efficient technology. On a principle level, the combination of ICT and SSL provide great potential to develop intelligent system solutions for smart cities and smart buildings. For example this flexibility enables solutions that provide the right light, in the right place, at the right time, for each and everyone. This means that it is possible to develop dynamic lighting systems that optimise the functionality and attractiveness for the users. At the same time focusing on the actual “usefulness” of each part of the light enable very large energy savings.

The report presents a mapping of positive examples of green business development projects, green business opportunities collected during the in-take workshop with the project partners and conceptual clarifications. A reframing of the green vocabulary is given in order to facilitate green business development for smart SSL systems. One ambition is to clarify the interconnection between the attractiveness of high quality installations of dynamic lighting and the long-term sustainability effect. From this perspective there is a risk that lighting solutions that are motivated by the achievement of primitive energy savings are likely to result in unattractive, low quality solutions that will in the long run lead to a bad reputation of the technology. To be able to accelerate business development for human-centric lighting solutions, customers need to recognize the benefits beyond high efficiency and cost savings, so that investments achieve a maximum shared value in making use of their social, environmental and economic sustainability potential.

2 The need for reframing

The presented mapping is intended as a toolbox that the project participants shall be able to use to clarify the advantage of a more advanced green business development framing. One main ambition is to clarify why it is so crucial, from sustainability point of view, to aim for really good solutions.

2.1 What's new?

In most respects this project's use of the Green Business Development framing is only a clarification and combination of already known concepts and priorities. For example the importance of a wide enough framing and a systemic view was highlighted already in the Brundtland report (WCED, 1987) and e.g. under the heading cleaner production during the Sustainable Development conference in Rio 1992. In 1995, the vital importance of the green discourse, for business people, was highlighted in the Harvard Business Review paper *Green and Competitive* (Porter et al 1995).

This discourse continues to attract broader interest. For example already the book *Factor four: Doubling wealth, halving resource use* presented 50 positive examples (Weizsäcker et al 1997). Influential business people are engaged, for example in the Club of Rome and the World Business Council for Sustainable Development, WBCSD. In this report, chapter 7 presents a present-day example of the engagement among financially powerful actors. One ambition with this report is to make the leading green business development theories (figure 3) more understandable and useful as one basis for a transformative change to humanly better lighting.

One interesting parallel that is mentioned already in (Porter et al 1995) is that there is an analogy between the earlier build up of understanding around Quality Management priorities and the ongoing build up of interest in Green priorities. The Quality discourse started by establishing Quality Departments, to sort the bad products away. It was an add-on activity and an additional cost. Toshiba and others developed advanced quality assurance programs aiming to avoid all kinds of production errors. Gradually integrated Quality Management has become a business necessity. The leading businesses have moved on to a advanced Quality based methodologies and tool sets to strengthen the core of their business development process, EFQM (the European Foundation for Quality Management), see www.efqm.org/efqm-model/fundamental-concepts.

Quality management has a genuine basis in avoidance of all kinds of errors. The analyses to find risks for errors provide valuable information about how the production can be improved. In analogous ways, energy analyses can be used to clarify which parts of the energy use are really useful for production of customer value. In an analogous way as for quality information, integrated utilization of energy information can be used to improve the core of the business and user activities.

2.2 A serious risk with primitive Energy Savings

Today it is a very pronounced political priority to save energy. When energy savings are made in a wise way the additional insights that can be obtained through the energy related analyses may provide guidance that enable development of superior solutions. However, single-minded energy and cost saving ambitions is a serious risk.

When energy savings are made for their own sake there is a considerable risk for serious negative indirect effects. The left hand part of the figure 1 below illustrates a generic principle for successful product and system development. In a competitive market, working in a proper way, it is only businesses that recurrently improve the wanted functionalities and reduce the not wanted effects that survive. The figure illustrates this for some aspects of the development of lighting.

The right hand part of figure 1 illustrates the risk for serious negative effects from energy savings ambitions. When energy savings are made in a primitive way there is a risk that some of the wanted functionalities get lost and also that not wanted effects are introduced (reintroduced). This happened when the compact fluorescent tubes were introduced as an energy saving invention. The early energy saving bulbs had long start up time, the quality-of-light was criticized, they did not fit in several old luminaries and they were not dimmable. This was a serious regress compared to incandescent light sources.

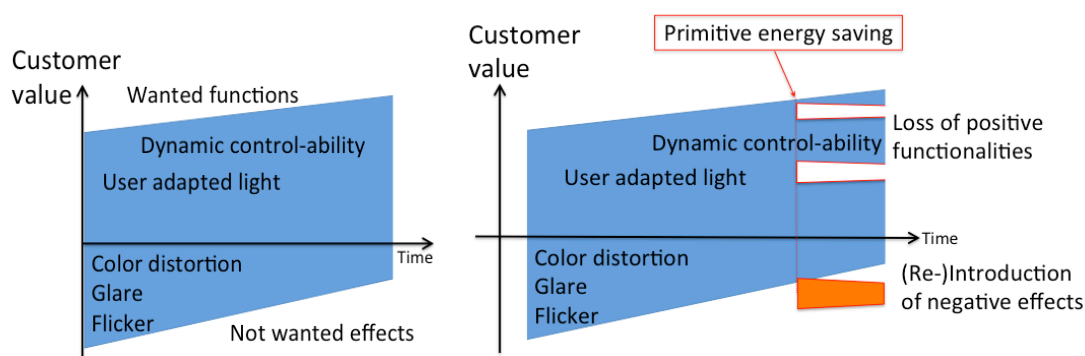


Figure 1 *The risk with primitive energy saving ambitions, for the Lighting sector*

One reason for why this happened was that the environmentalists and politicians were focusing exclusively on energy and cost savings, by themselves. There was limited market interest in qualitative improvements and consequently it was hardly possible to get going with value enhancing innovations. The end result was that a lot of people got sceptical to low energy bulbs, and they still are. We are still struggling to convince people that low energy light sources can produce very nice lighting.

A similar risk applies for energy saving lighting control systems. When energy savings are made in a primitive way some of the positive functionalities are often lost and some negative effects often appear. However, it is possible to reverse this interconnection.

Really good lighting systems should provide exactly the light that is needed and wanted and there should not be too much other lighting. A wise energy analysis should take a starting point in serious knowledge about needs and wants. The investigation should focus on clarification of what the users need, want and appreciate. This resulting information that can be used as additional guidance for development of really nice, value enhancing lighting solutions. An energy analysis can be used as a way to sharpen the enquiring regarding which parts of the, present and potential, lighting and functionalities it is that provide customer value. This is quite possible, but it is difficult and to achieve this it is fundamental to take a main starting point in the core business values.

3 Conceptual Clarifications and Definitions

The SSL-erate perspective on Green Business Development is that:

Intelligent Green Business Development aims to facilitate deployment of sustainable solutions, by making them ever more attractive for users, customers, societal actors and businesses.

The foundation for this concept is that it is a kind of Business Development and that the “Green” is a qualifier for what kind of Business Development. The basis for the SSL-erate perspective is that the Business Development should be effective on a free market where the customers make their own choices.

The basis is that we are aiming for a sustainable society that engage in further sustainable development of itself. However, several aspects of the societies of today are hardly sustainable, e.g. the short-termism (economically), the unemployment (socially) and the narrow-mindedness (environmentally). Furthermore, sustainable development is a process of change, i.e. there is a need for reasonably continuous transformation of the systems that have been built.

In this project we use the term Green Business as a concept for the transformative build up of a higher level of sustainability. To get started with Green Business there is a need for Development Green Business ventures, which is the focus for this WP2. The basic assumption is that intelligent SSL based solutions give very interesting potential for sustainability improvement. For the work to accelerate sustainable deployment of SSL we use the term Green Business Development.



Figure 2 *Conceptual definition of Green Business Development in relation to the need to accelerate transformation to a more sustainable society.*

We are well aware that Green Business tends to be perceived as business development to achieve environmental improvements, often arguing as if this Green Business could work in isolation from the social and economic sustainability dimensions. But we have not found anyone that really is proposing that Green Business should ignore the social and economic dimensions. Consequently, we here include these dimensions in the Green Business development ambition.

Furthermore, we do not think it is reasonable to work with the green ambition as an add-on that is separate from the core of the business development, see also section 2.1.

One aspect here is that the Green Business Development and also the Business Development in general can be influenced by rules and regulation. This is important as toolbox of drivers for change and motivation for green investments. It is one reason for why potential for green business developments is so great. But this is not shown in figure 2. From a deeper environmental science point of view we are using an anthropocentric perspective.

3.1 The Cloud Level of Market Development Potential

SSL-erate aims to promote innovative developments that enhance the customer and society value of SSL. One main ambition is to make use of knowledge about the health and wellbeing value of well-adapted lighting. This comprises more complex offerings, including intelligent systems analyzing, interpreting and acting on sensor information and various forms of more advanced user interfaces.

Cities will be able to procure more advanced solutions that can be used to make their city more attractive for their citizens, visitors, businesses, venture capital and various development actors. The attractiveness is to be found in several different value dimensions and suppliers will thus find new opportunities to differentiate their offerings and soften the pressure for commoditization. The higher customer values can be reflected in correspondingly higher prices. At the same time, the investments in those value enhancing and simultaneously energy saving solutions can be used to create numerous regional green jobs.

The more advanced solutions provide great potential as tools for sustainability improvements in the social dimension, for example by means of better living and working environments in preschools, schools and for elderly people. The problem is to get going with a market creation that open up for business development that make these new higher value solutions possible to buy and sell.

There is a need for Green Business Development as a driver for transformative change to lighting solutions with higher sustainability value. The target is rather unclear, but definitely higher than the solutions we can find on the present lighting market. It's not sufficient to set the target at the treetops, so to speak, but at the level of the clouds above the trees.



Figure 3 The potential market for higher value SSL solutions. SSL-erate is one platform for dialogue among the project cities, clusters and suppliers. The market (cloud) is a platform for interaction between potential customers and suppliers.

The complex offerings draw on a wider base of resources and competencies, so suppliers will increasingly find it attractive to collaborate in various forms of open innovation to make the offerings real within a reasonable time frame and with reasonable investment and risk.

The main challenge for this market development is to reach a mutual understanding between cities and suppliers and clusters about what can actually be achieved, and that this understanding is at the enhanced value level. The market to be created, will enable meetings of various actors and common understanding to be reached.

3.2 The development of the level of understanding

In the in-take workshop in Lund we discussed three levels of interest and understanding, the present level, the cloud level (aiming for the stars) and the treetop level describing the best examples so far. This kind of framing can be applied for several different dimensions e.g. the Technical, the Light Quality awareness and the way of working with Green priorities.

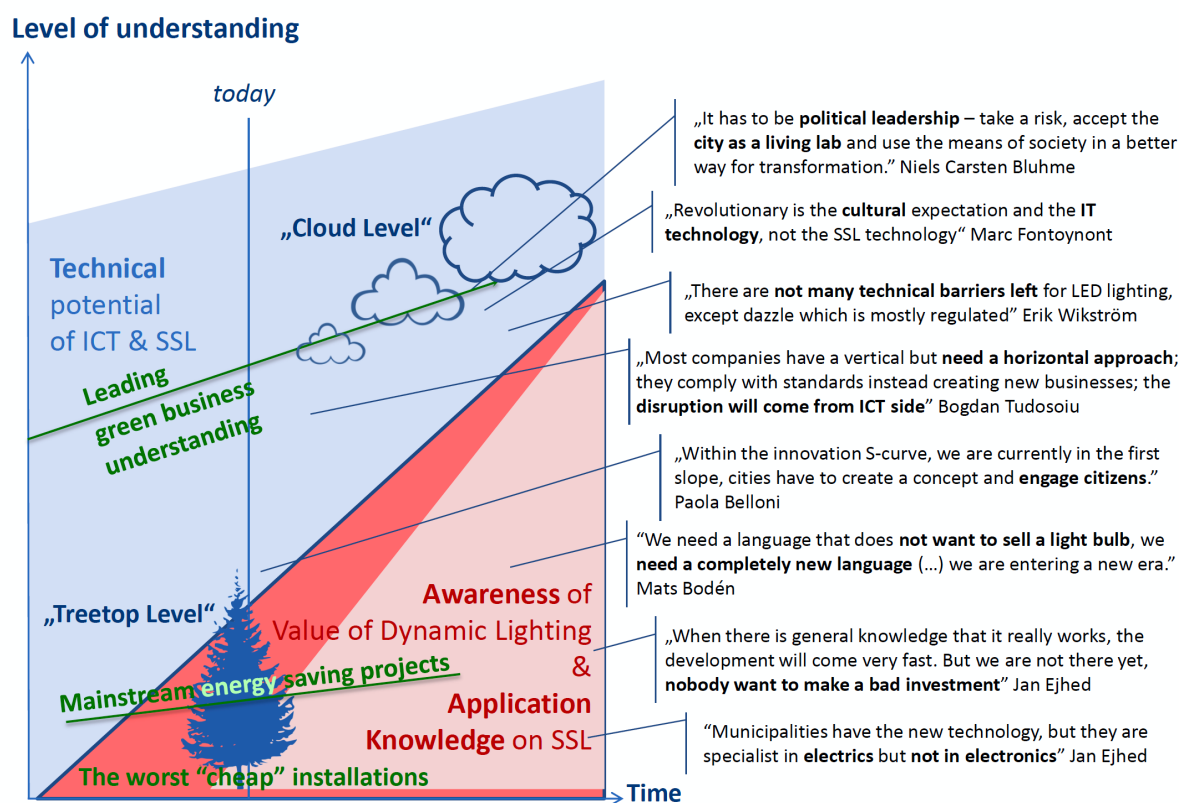


Figure 4 Illustration including quotes from discussions on SSL green business development.

1. **The technical dimension:** It is obvious that already the ICT, SSL, sensors and user interfaces of today provide almost unlimited freedom of action at the cloud level.
2. **Knowledge & awareness:** The situation is much more complex regarding the awareness on the human value of intelligent dynamic lighting solutions. It is difficult to describe why there is a considerable need for change. As an indication it is relevant to consider that the latest hundred years we have become accustomed to static, somewhat reddish, slightly flickering light environments where we essentially have been aiming for more lumens and the same light everywhere, all the time. However, the human sensory system is adapted to the varying light in nature, where the colour composition, the proportion of directional light and the intensity varies. We know that sometimes we want functional light and sometimes we want cozy light, and also darkness. We know that the glittering light from moving water and in the forest feels good, many appreciate the play of light at sunrise and sunset, and we appreciate candlelight dinners. In this perspective we have the reddish incandescent light at the todays level and the full appreciation of the value of dynamic flexible lighting at the cloud level.
3. **Testing** is important as a basis for development and to enable buildup of knowledge and awareness. The present level of light testing tends to focus on lux-values in single points. So far, there is not much generic testing methodology for the functionality of lighting systems and hardly any hardly any readymade technical testing tools to assess the experience of the total light environment in a room or for a certain place.
4. **Green business:** In the Green business dimension the present level may be interpreted as the general common understanding about the Green, the Environmental and also Sustainability as a kind of add on, which aims to reduce the negative environmental effects. In that case we have the risk with primitive energy savings that is described in chapter 2.2. At the cloud level Europe makes green investments in transformation to sustainable solutions. We aim for solutions that dynamically provide the right light, at the right places, at the right times and by also reducing all other kinds of light we can get better lighting effectiveness and thereby almost automatically also energy effective system functionalities.

3.3 Inter-operationability

The above and figure 5 is inspired by the InterOp i.e. Inter-operationability discourse, (Palfrey, 2012) with a focus on the importance of simultaneously working with all the four levels:

- A. Mutual understanding
- B. Organisational collaboration
- C. System coherence
- D. Component compatibility

The Technical interest focuses on the D and C levels, but A and B are also important. Awareness has a foundation at the A level. The ability to “test” is vital to link A, B and C, and also D. Green Business Development has a base in A and B, and is vital to link all the four levels.

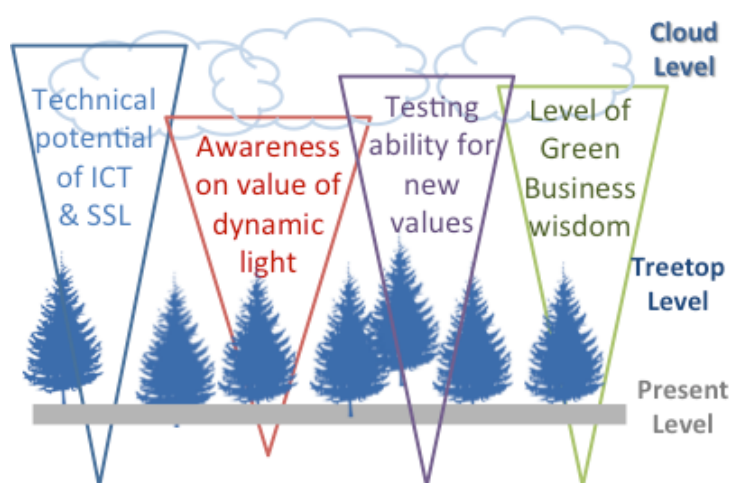


Figure 5 Four dimensions of SSL related knowledge foundation for transformative change.

It is obvious that the presently available technology provides a lot of new value potential at the cloud level, much more than what is presently activated. There is much less general awareness about the vital importance of the cloud level of knowledge and mutual understanding for the Awareness, Testing and Green Business Development dimensions. However, the cloud level is equally important for those dimensions.

The Figure 5 pyramids illustrate that there is a need to activate a lot of knowledge at the cloud level to get going in a good way. The basic idea is that the present level is understood, whereas there is a much larger need for clarification at the cloud level, which is illustrated by the upside down pyramids. However, the existing foundation for this new SSL and smart system thinking is rather limited, as illustrated as a narrow base at the present level of understanding.

The four dimensions in figure 5 are related in the sense that the Testing ability for new values will help to raise the Awareness on value of dynamic light. When Green Business Development is permeated by Green Business Wisdom, the Technical potential of ICT & SSL can be mobilized and used to create more appreciated lighting with sustainable lighting solutions.

As one example, the present level of testing knowledge and methods has been developed for the traditional lighting and around the traditional single point light measures for a static light level, mainly lm and lux. To be able to clarify the cloud level of dynamic light values there is a need for additional methodologies. In a somewhat analogous way the green business interest so far tend to focus on the energy saving in itself. The potential sustainability values of the smart lighting systems of the future are very much broader and greater.

3.4 Level 3 as a main key to leading deployment of Smart SSL

Smart Lighting aims to provide the right light, at the right place, at the right time, for each and everyone. The Smart Lighting conceptualisation so far focus on the steering aspect of the lighting control – virtually as if it was easy to know which light is right. However, it should be noted that, the most difficult part of the system development is to interpret the changing needs and situations, to determine which lighting is "right", at different times, for different purposes, in different places, for different individuals.

Table 1 highlights the distinction between the traditional control (2) and the need for intelligent interpretation of the needs for various kinds of light, light based services and other functionalities (3). So far, most of the interest in control systems for lighting focuses on the on/off/dimming steering of light sources (2). The crucial importance of the interpretation of the human needs, wants and desires (3), which is indispensable to enable a more appreciated dynamic user and situation adapted lighting, tend to be neglected.

Table 1 *The needs and wants perspective for more advanced lighting and three levels of technology, from traditional lighting towards the present potential for smart lighting. Before and during the Malmö workshops level 3 has been brought to the fore as a key to creation of a higher level of value.*

		Smart Systems	City dialogue (ENIGMA)
Customer/User perspective	Needs, problems & opportunities	People & light <ul style="list-style-type: none"> • Human desires • Cultural needs • Social needs • Psychological needs • Physical /medical need • Sensory functions 	Joint Ambition for City Development Aiming to improve: <ul style="list-style-type: none"> • Quality of Life • City attractiveness • Safety • Effectiveness
Technology perspective of suppliers	Solution level 3	Interpretation <ul style="list-style-type: none"> • User Interface • Artificial Intelligence • Knowledge databases • Access to Cloud Data • Light Distribution Meter • Sensors 	Supervision and User interface <ul style="list-style-type: none"> • This is a main level of interfacing to the joint ambition. • Bottleneck in the development of smart cities and intelligent lighting.
	Solution level 2	Traditional lighting control <ul style="list-style-type: none"> • Steering of light sources 	Lighting Control <ul style="list-style-type: none"> • Numerous suppliers
	Solution level 1	Lighting <ul style="list-style-type: none"> • Light sources and luminaires 	Lighting <ul style="list-style-type: none"> • Light sources and luminaires

The importance of monitoring and intelligent interpretation is not noted

It seems as if most people are thinking as if the goal was to make a modified version of static lighting design. This is not so strange, because, it is difficult to assess the human needs, wants and desires for substantially better lighting. Regarding the potential, quite a number of people have noted that SSL and auxiliary technologies enable almost unlimited flexibility to dynamically control the lighting. However it is hardly noted that it is a fundamental challenge to develop system solutions with sensors and user interfaces that enable continuous assessment of the users needs and the situation and make intelligent interpretations of the need for various characters of lighting, at different times, for different purposes, in different places and for different individuals.

The more advanced solutions arise when the subsystems (3) are developed to incorporate new and future knowledge about the users and the user situations, to be able to interpret the sensor generated data for meaningful contextual adjustments of lighting. This includes high tech lighting, but also subsystems made possible through the rapid development of the ICT industry and the generation of new research results on the effects of different and varying light on people.

3.5 Co-branding to enhance the value of green ventures

One possible method to build a self-reinforcing interest around green concerns and ventures is to make use of co-branding principles. During the Malmö and Lund workshops co-branding has primarily been presented and discussed in the open innovation context.

The basic principle is that several different stakeholders contribute to and make own use of the publicity around some green venture, for their own interest, for example:

- A city may be able to show that they are proactive by presenting that they are investing, e.g. in intelligent school lighting, with some kind of “brand” naming.
- The building company that arrange the design and installation may be able to make use of the positive example in their branding.
- The headmaster of the school may be able to make use of the same solution as a part of the presentation of her school as good place to work – for recruitment purposes.
- The schoolteachers union and also media may be interested in presenting what is happening as a way to show that they are active proponents of sustainable workplaces.

That several actors make us of the same good reference in their marketing will increase the image of the venture and make it more well-known, i.e. the brand of the venture will be built stronger and quicker and thus be of more value in the branding of each one of these different actors. There is a mutual reinforcement of the brands of the actors and the venture.

One background for why it is interesting to invest in improvements of working environments is that there is a lot of public interest around h CSR, Corporate Social Responsibility, and also Societal Social Responsibility. Now that we get ever more indications that the character and quality of the light influence health and wellbeing it is becoming a social responsibility to try to make use of the new opportunities. The precautionary principle is also promoting early action. The novelty value of early action will increase the attention. Being an early mover may be in itself be a vital part of the image: “Who was number two on the moon?”

4 Case studies, interviews and in-take workshop

This section reflects on prior research on positive examples of pilot demonstrations as well as the outcomes of the intake workshop on green business opportunities from Jan. 23th in Lund, Sweden. Interviews and discussions with inspiring experts were undertaken to identify positive examples of SSL demonstration projects (see as well quotes in Figure 3, chapter 3.2.).

The collected information is summarized in the Appendices: The content of these interviews and conversations with experts is summarized in Appendix I, the summary of positive examples can be found in Appendix II and the summary of workshop notes in Appendix III.

4.1 Reflections on present level of positive examples

In the search for examples we have been looking for different kinds of positive examples that indicate a significant improvement from the user point of view. We have tried to select representative examples, but since we did not made a scientific evaluation of the statements and research results, these are to be seen indicative and only representative to the specific local setting.

The application areas included e.g. dynamic lighting in schools, hospitals and elderly care as well as street, traffic and city centre lighting. The majority of reports emphasise the direct cost and energy savings as well as the reduction in carbon emissions. For urban lighting, further benefits that are mentioned are increased traffic safety and personal security (e.g. better face recognition), reduced light pollution, targeted lighting, city branding and tourism (e.g. giving the city a “nocturnal face”). For indoor applications, the major reported benefits are better learning environments and working productivity (e.g. increased reading speed for students), health & wellbeing (e.g. increased social activity and conversations for dementia patients). The economics of these indoor solutions and research pilot projects were barely communicated or measured.



Figure 6 Interesting SSL demonstration examples

An inspiring collection of positive examples and existing pilot projects can e.g. be found through LUCI in the „Plus Mainstream Guide – Guidelines to cities on sustainable public lighting strategies“ (2012). Partner cities like the City of Lyon or the City of Eindhoven have initiated and implemented SSL master-plans and presented benefits achieved so far. Further, in 2012 the Joint Research Centre of the European Commission published the Scientific and Policy Report “Led projects and economic text cases in Europe”, where 106 LED case studies from 17 European countries have been reviewed. The report is considered to give valuable and representative information on the economics of SSL projects. Therefore the main conclusions are presented here with following figures and statements:

- Resulting energy savings range from 10% to as much as 90% (59% on average)
- In many applications, LEDs are competitive (offering payback times from 2 to 10 years)
- In a large number of projects (trials and test cases), the economics are not relevant, not measured or would not be advantageous. Yet, all applications show a clear potential for competitiveness in the (near) future.
- Most successful applications, in terms of savings and economic considerations, are 1) replacement of incandescent light bulbs in traffic light systems, and 2) replacement of halogen spotlights in indoor applications.

More interestingly for the SSL-erate project, the report also refers to so-called “co-benefits” of LED projects. These address low maintenance costs, improved lighting characteristics, good indoor and outdoor lighting quality, improved ambience and atmosphere (especially for indoor lighting), no UV radiation, environmental benefits and improved security (road safety). These are from some cities highlighted as the major benefits and therefore surpass the benefits from energy and cost savings.

As indicated in Figure 6, many cities throughout Europe already have successfully implemented interesting SSL pilot projects that go beyond energy and cost saving aspects. In the following, two well documented SSL demonstration cases are presented which address the economic as well as a higher added value of the implemented solutions. In 2010, the City of Rietberg and the City of Freiburg im Breisgau won the Federal Research Ministry competition *Communities in a New Light*. A grant of EUR 2 million was given to the cities to implement their lighting masterplans, which also required them to share their experiences. From the earlier presented cloud model point of perspective those are examples of the tree top level.

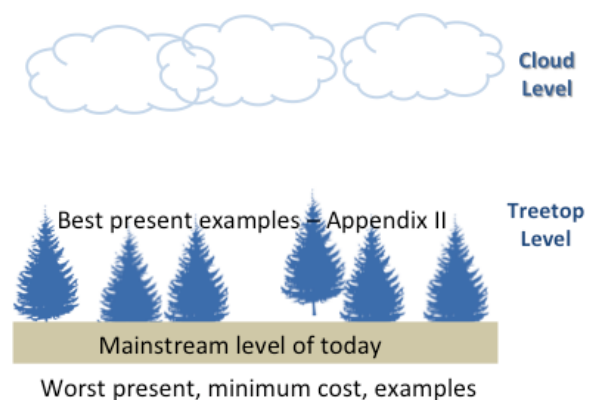


Figure 7 The value level of best present demonstrations in relation to the cloud level

Well documented demonstration example

Case#1: Historic Town Centre of Rietberg, Germany

In order to raise the lighting quality to DIN level (before not compliant with DIN EN 13201) and as part of its climate policy, the City of Rietberg decided to change the entire city centre lighting to LED (total installation of 195 LED lights). The city won LUCI's city.people.light award 2013. The city would have realized the masterplan as well without the grant.

Economics & Benefits of the project:

Mayor of Rietberg: *"With this project we set a milestone of modern urban development and climate policy. Our contribution can be a proof of the successful integration of energy-efficient LED lighting in an historic setting for all cities with historically valuable substance."*

- Reduction of electricity 28134 kWh/year (60%), representing a reduction from 46.675 kWh/year to 18542 kWh/year, calculated based on several assumptions like dim levels of 30-100% and operation time of 12 hours/day in average. Please note: Rietberg has approx. 30.000 inhabitants
- CO2 reduction of 29 t per year
- Total expected savings from reduced energy and maintenance of 117.000 EUR in 10 years
- Improved wellbeing and security through guiding solution for visually impaired citizens (in

cooperation with the regional association for blind and visually impaired people LBVS e.V.)

- Attractiveness (“nocturnal face”) and international recognition increase tourism as well as number of people staying in the city centre and therefore local businesses
- extensive evaluation (survey in cooperation with FH Bielefeld University of Applied Sciences) lead to positive results e.g. in terms of light quality, sense of security, face & obstacle recognition
- “The result changes the character of the city and turns it into a safer, more comfortable, and inviting city center”, city.people.light award jury Rafael Gallego

Challenges

- Alignment work with monument preservation office as well as citizens for new installations on their private ground. The City of Rietberg explained that these discussions were unproblematic.

Source: Project evaluation published in “LICHT 1–2 | 2014”, personal communication with project manager Rüdiger Ropinski, City of Rietberg

Well documented demonstration example

Case#2: Freiburg, Germany

In 2010 the City of Freiburg (200.000 inhabitants) won the Federal Research Ministry competition *Communities in a new light*. A grant of EUR 2 million was given to the city to implement its lighting masterplan, which required Freiburg to share its experiences. The inner-city lighting (5% of whole Freiburg) was upgraded to modern LED technology with 223 historic and 80 technical luminaires, including the long-awaited desire to completely illuminate the cathedral of Freiburg. Without the grant, the city would not have been able realize the masterplan

Economics & Benefits of the project:

- Reduction of electricity 23.100 kWh/year (64 %)
- Evaluation results: The sense of security has increased significantly among citizens and pedestrians after the conversion and the light was perceived to be very pleasant.
- Freiburg is known to be a model “Green City”, therefore the lighting solutions supports its environmental and climate policy and increases international recognition and branding

Challenges

- Alignment work with monument preservation office and private ground owners
- Construction work (e.g. removing cobblestone pavement), 100% funding covered these costs
- Quality of lighting solutions (independence of planner and solution provider and high reputation brands with good warranty highly recommended)
- Prototype testing requires time and resources (e.g. prototype for cathedral lighting got condense water, solution got improved and is working now)
- Time planning (master plan had to be realized within 2 years, otherwise no guarantee for 100% funding, Freiburg applied for extension and could finalize implementation)

Source: “Publication “Kommunen in neuem Licht”, Interview with project manager Franz Bühler, City of Freiburg and evaluator Prof. Paola Belloni, LED-Netzwerk Schwarzwald www.hess.eu/en/Inspiration_Effizienz/Projektsuche/Projekt_BMBF__Freiburg_in_neuem_Licht

A comparison of the case studies of Rietberg and Freiburg provides interesting insights and interpretations. According to the interviews, Rietberg would have implemented the lighting master plan without the financial aid. As a mid-sized town of 30.000 inhabitants, the administrative hierarchy is rather low and enabled quick decisions and easy communication with citizens and stakeholders, that all stand in for the city’s vision. The project manager reported only very few

challenges or barriers that came up during the implementation of the project. Freiburg as “Green City” also has a very strong political sustainability agenda, but would not have invested into the switch to LED at this stage, since the majority of installed lighting sufficed their local requirements. The cooperation with the technology provider turned out to be more challenging as expected (e.g. prototyping, temporary insolvency of the company) and alignment as well as construction work added more complexity and potential costs. Overall, the city is as well very satisfied with the solution and its positive effects for citizens.

The presented projects, above and in Appendix II, illustrate an untapped potential that many more cities could make use of to make their cities more attractive for their citizens, visitors and business development. These cases show a number of benefits that have been achieved through the SSL projects so far. But, these cases do not represent best practice cases on the desired “cloud level”. From the cloud perspective this is a rather immature market. One limitation is that the so far used lighting metrics are not really adapted for assessment of intelligent system solutions. Most positive examples emerge from cities with a strong sustainability vision and political commitment, and were often partly or fully enabled through public funding or research projects.

4.2 Green Business Opportunities

During the intake workshop in Lund, the needs and opportunities were discussed more in detail with the project partners. SSL solutions have the potential to lead to a higher value are for example through the use of dynamic instead of static lighting, changing light colors and creating ambience in a contextual setting. The prior expert interviews and moreover the group discussion during the green business workshop identified following areas for green business development:

4.2.1 Opportunities for indoor public spaces:

- **Elderly care**
 - *Problems to be addressed:* Less injuries, increased health and wellbeing, increased social activity & communication, way guidance to facilities by night, friendly atmosphere for residents and visitors, circadian rhythm, remote care (e.g. check weather residents are healthy and alive including signals for neighbors or emergency)
 - *Relevant lighting functions:* e.g. color of light, frequency of light, lighting design (e.g. for way indication by night without intense brightness), mood lighting
 - *Potential stakeholders:* e.g. municipalities, designers, architects, elderly cares, health insurance companies, facility management companies, research institutions, etc.
- **Health care**
 - *Problems to be addressed:* 24hour situation (circadian rhythm), conflicting demands of residents, patients and staff; recovery time of patients, wellbeing of patients and visitors, anxiety
 - *Relevant lighting functions:* e.g. color of light, frequency of light
 - *Potential stakeholders:* e.g. hospitals, municipalities, research institutions, patients

- **Schools**
 - *Problems to be addressed:* improve learning environment, structure class lessons according to task and time of day (activate, calm, concentration, creativity), decrease hyperactivity, increase reading speed
 - *Relevant lighting functions:* e.g. color and frequency of light, mood lighting, dynamic light, ambience, automatic interpretation of user situation
 - *Potential stakeholders:* Municipality, citizens (students, parents, society), creating a multi stakeholder living lab in education like e.g. Peter Kisch (Lund) creates a win-win approach of building a “world class learning environment”
- **Museum & Art**
 - *Problems to be addressed:* less damage to old paintings, e.g. relevant for Bassano retrofitting of historic office buildings in-/outdoor, art projects with e.g. local artists
 - *Relevant lighting functions:* e.g. UV neutrality, design, light color, light & sound
 - *Potential stakeholders:* Municipalities, galleries, artists, historic public buildings
- **Working places:**
 - *Problems to be addressed:* wellbeing, productivity, personalized lighting adjusted to task and daytime (meeting room/atmosphere, workplace/concentration, coffee/recovery), safety guidance to emergency exits, image of a company (e.g. hosting meetings), guidance in complex buildings (e.g. universities, airports, hospitals)
 - *Relevant lighting functions:* e.g. level and colour of light adapted to the area (meeting room, coffee, workplace), lighting design
 - *Potential stakeholders:* e.g. companies, in the service sector, building management, etc.
- **Buildings and areas (e.g. schools, universities, airports, hospitals)**
 - *Problems to be addressed:* orientation, security, maintenance, break-ins, light pollution from light outside of the buildings shining into apartments in dense areas
 - *Relevant lighting functions:* way indication, security alarm, lighting design
 - *Potential stakeholders:* Police, municipality, event management, tourists, airports, city planners
- **Shops**
 - *Problems to be addressed:* increased wellbeing (e.g. light pollution causing headache for employees), productivity, highlight products, feel of privacy in crowded places
 - *Relevant lighting functions:* e.g. target lighting, mood lighting
 - *Potential stakeholders:* e.g. local businesses, customers, retailers, employees

4.2.2 Opportunities for urban public spaces:

- **Street lighting (road and pedestrian)**
 - *Problems to be addressed:* Increase personal security, light pollution, decrease crime, increase road safety, decrease energy consumption, decrease accidents, guidance for visually impaired citizens
 - *Relevant lighting functions:* e.g. adjust light to activity, light color, rendering, automatic alarm functions (e.g. in case of accident, crime, rape)
 - *Potential stakeholders:* e.g. municipalities, police, citizens, local businesses, hospitality, car manufacturers (integrate ICT), travel apps provides, visually impaired citizens, cyclists

- **Traffic lighting**
 - *Problems to be addressed:* better traffic flow (guide traffic at road deviations; “green wave” for vehicles towards traffic lights; speed control, ambulance guidance, distribution of free parking places; tourist information (visual & sound guided tours on sights, guidance for tourists inside/outside the city); driving safety; time, energy & fuel efficiency; public security; fun
 - *Relevant lighting functions:* e.g. automatic sensors, change or color for indication, connectivity to mobile applications, combination of light and sound system in pole, GPS
 - *Potential stakeholders:* Citizens, hospitals, police, fire brigades, construction companies, municipalities, ICT sector, tourists, tourist agencies, local businesses, etc.
- **Public space lighting (Parks, urban furniture, playgrounds, sports)**
 - *Problems to be addressed:* personal security, light pollution, decrease crime, increase road safety, decrease energy consumption, alarm and signaling in case of screams or, adjust color to different moods (e.g. sports, date), adjust light direction to function (e.g. highlight roads, obstacles, football goals, beautiful sights, interval training)
 - *Relevant lighting functions:* e.g. light color, design integrity in furniture (e.g. banks, bus stops), better face recognition, automatic alarm functions (e.g. in case of accident, rape)
 - *Potential stakeholders:* e.g. municipalities, children, runners, pedestrians, tourists, schools, event management
- **Public events and rush hours**
 - *Problems to be addressed:* Avoid crowd panic, crowd guidance, violence decrease
 - *Relevant lighting functions:* mood lighting, calming effect
 - *Potential stakeholders:* Police, municipality, event management, tourists
- **Branding and Lighting Festivals:**
 - *Problems to be addressed:* City’s identity and beautification, giving the city a “nocturnal face” instead just extending the day into the night, international recognition
 - *Relevant lighting functions:* all
 - *Potential stakeholders:* Municipalities, local businesses, city ranking institutions, potential new residents, tourists

Overall result when previous areas are addressed and lighting is also used for city beautification, leading to define a city’s identity and attract tourists as well as new residents and businesses. The attraction can also result in people and businesses staying in a city, instead of moving somewhere else, cf. Rietberg. There is a branding opportunity both for the city and for the suppliers, so co-branding may be an effective way of realizing these values.

As illustrated by these green business opportunities, advanced human-centric lighting solutions provide twofold opportunities and values: On the one hand, **in terms of efficiency**, one can say intelligent solutions adjust to **no people – no light**, meaning solutions provide the necessary level of light according to present activities. On the other hand, in terms of enhanced **human-centric added value**, one can say **no light – no people** or **light = people**. This refers to the often only subconsciously perceived positive effect natural light and artificial dynamic lighting has on pedestrians, patients, residents, children, sportsmen, elderly people, car drivers, tourists and many more.

4.2.3 Reflections and implications on Green Business Opportunities

These opportunities are in a multitude of application areas and the problems to be addressed also represent a great variety. However, we can also note that for many, or all, of them they are aiming to contribute to the content of the joint ambition for city development, i.e., quality of life, city attractiveness, safety and effectiveness. Of these, improvements of city attractiveness through esthetic improvements with creative lighting may be one of the more accessible opportunities. Still, other problems dominate, demonstrating that there is a budding interest for new functions on a new and higher value level. The opportunities identified in this initial mapping, all need innovation on levels 3 and 4.

There are some overlaps between the opportunities regarding lighting functions, e.g. color of light and frequency of light, and the use of sensors and the need to analyze and interpret the data from the sensors. There are also overlaps of opportunities appearing in several cities, and probably in many other cities as well. This indicates that there is potential for economies of scope and scale, and that the use of open standards and modular systems could potentially be useful for speeding up the process, as well as reducing cost and risk. Therefore solutions could be made available at lower price points than otherwise, increasing the chance of larger sales volumes.

There are potentially many different stakeholders whom may get involved in the different business opportunities, and there is also some overlap. Most noteworthy are the cities themselves, but different units may be involved for different opportunities. This situation stresses the need to raise awareness and interest for a rather large group of people, should several of these opportunities be developed at once in the same city.

The stakeholders will in various ways affect the freedom of action for radical innovation. They have interests that may be the same, or not. They may have competencies that can support the innovation process in crucial ways, but they may also introduce boundary conditions, that can make innovation difficult. The ability to work with and develop common interests, and constructive and supportive relationships with stakeholders will be key to successful open innovation.

If some form of shortcoming results in an unattractive SSL installation, or a resulting light environment that is only almost as good as the light from alternative lighting solutions, this may affect the SSL “brand” in a negative way, although not formally registered as a brand. This in turn may hamper other cities and other customers willingness of invest. In an analogous way, creative and good lighting installations, may enhance the reputation and positioning of SSL technology as a brand, and create a demand for similar high value installations elsewhere. There will be learning between stakeholders and both good and bad examples may have ripple effects, which need to be taken into account. The risks of negative reputation effects seem to be larger if the installations are related to the SSL-technology as such, since, in a sense, the technology is labeled in the same way in both good and bad installations. From this point of view, the “SSL branding” risk seem is more limited for installations that have a strong association to the desired customer value.

Branding, as a phenomenon and as a business opportunity, is not in the same category as the other ones, as it is a way of getting the most out of the image qualities of all lighting activities. It needs a

different kind of work, and generates a more indirect value. Branding could probably also be more effective if this aspect were included early in the process of the customers and the suppliers, or indeed by all stakeholders, so no opportunities are missed. An interesting case of co-branding is how BioOffice in Norway collaborates with its customers.

That the business opportunities mentioned above are found on levels 3 and 4 also means that the offerings and solutions developed towards them tend to be more complex, involving complex interactions with customers and many different competencies and technologies. This increases the likelihood that it will be difficult for any one company to successfully innovate on their own. The collaborative open innovation process in the SSL-erate project will facilitate the interaction of different companies, each controlling part of what is needed, but not all. This process will also facilitate the participation of SMEs in developing new and innovative solutions for these higher value levels, thus increasing both the number and the diversity of participating companies.

The more complex offerings and solutions will take longer to develop and could also be perceived as having a bigger risk. Open innovation may contribute in speeding the process up and letting the participating companies share risk. The PCP (Pre-Commercial Procurement) process of the ENIGMA process will also help in turning a vague and uncertain demand in a distant future into a clearer and less uncertain demand within a shorter time span.

4.3 From Business Opportunity to Business Development

The possible application areas of interest for the partner cities and beyond implicate several bottlenecks but also promising untapped potential to accelerate the development of human-centric lighting. Green businesses make use of this still untapped potential to close the gap between our (unexpressed) needs and desires and the readily available technical solutions. For example in the case of the Community of Albertslund SSL lighting solutions have become the gateway to the smart city development. Accordingly better lighting provides access to neglected areas within the city, better health, increased wellbeing, barrier free access for impaired and elderly citizens, more time available, higher appreciation of indoor and outdoor activities at any time of the day and many more. In order to turn these opportunities into actual business development, the discussions and research findings brought up following important **bottlenecks** to tackle and **opportunities** to consider:

Stakeholder engagement

- **Identification of relevant actors:** The change in value chain structures, higher complexity from production to installation, more service oriented solutions as well as the principal-agent-problem require a holistic view among various stakeholders. Businesses need to develop a more horizontal instead of vertical approach. Stakeholders to consider are e.g. ICT companies, property companies of local councils, facility management companies, design & architecture offices, tourist sector etc.
- **Capacity building:** Today, relevant stakeholders still have poor knowledge about new functional opportunities and technical issues. The municipalities lighting related staff are used

to work with electricians, but not with electronics. Therefore, there is a need for vocational training.

- **Risk aversion:** It is important to consider that people are more prone to take risks when they are about to lose something. But, when you have to change it is usually too late. It is important to find ways to overcome risk aversion and to develop ways of risk sharing!
- **User engagement:** Involving citizens in the development, e.g. various user groups, people with impaired vision etc. to understand their needs, to experiment and to improve solutions for maximum shared value. Therefore, a good **user interface** is needed between the municipality and the users. It is better to start with a well functioning platform due to complexity. This gives the opportunity to learn and see in which ways people use the solutions, or not use them.
- **Finding sponsors:** Branding of solutions and collaborations with various companies or organizations offer opportunities for alternative finance of pilot projects.
- **Openness:** In terms of engagement, thinking out of the box, sharing of information. A crucial aspect here is honesty and trust building to collaboratively develop business ideas

Communication

- **Need for a completely new language:** Today's communication uses rhetoric that intends to "sell light bulbs" or "fill sockets". In order to be able to create a market for more advanced systems and smart lighting it is vital to consider more dimensions. It is important to promote the function and not the product, therefore communicate human-centric *characteristics & qualities* of light
- **Need to adjust language:** To promote products and solutions, the wording and language needs to be adjusted to local preferences, understanding and areas of relevance. E.g. "green" can be misunderstood to only consider environmental improvements; "sustainability" might work better but has a similar risk. Communicate value creation and functionality is important to make new products and solutions attractive for customers.
- **Need to increase awareness:** Too many potential customers are satisfied with static, low quality lighting and do not acknowledge the current situation to be problematic. Human-centric SSL brings a solution to a problem that many customers are not yet aware of. Promotion according to the AIDA model (awareness, interest, desire, action) can increase number of customers
- **Timing:** The right timing is a crucial issue for business development. High quality green SSL solutions cannot be pushed on the market when potential customers are not yet sufficiently aware about the significant advantages of such investments.
- **Promotion & show cases:** Once initiated, the solutions should be promoted on a local level as well as on a regional level. Including not only to citizens, but also local businesses (e.g. design & architectural offices, producers of high tech solutions (e.g. for electrical vehicles) to maximize outreach, synergies between businesses, reputation and follow up projects.

Value creation

- **Better value for money:** Do not only generate cost savings, but release non-monetary benefits. So far the main focuses have been energy saving, maintenance and quality, to reduce the life cycle cost. We should aim for **Win-Win-Win solutions:** There is a need for benchmarking to clarify the value-for-money.

- **Efficient and effective use of existing funds:** A priority for cities is to identify the lighting costs per year and the actual budget for lighting. According to the achieved effect, not only budget for lighting can be invested for new solutions, but also related funds e.g. dedicated to marketing, tourism, climate protection, public safety or health can be considered.
- **Quality assurance:** Certification systems need to be considered and may vary according to different customers, markets, countries etc. Further, the city planner and technology provider should be independent to avoid conflicting interests (e.g. cost saving from provider side vs. long lasting and high quality implementation from customer side)
- **Reputation of SSL solutions:** Being aware of threat that the brand and reputation of high quality SSL can be destroyed by bad installations that use technology only for energy savings instead of user value. Communication of successful demonstration projects and evaluations can increase trust and accelerate business development

Demand side driven approach

- **Demand side as driver for change:** On the supplier side a lot of technical potential is available, but the customer side of the market is more uncertain. *Important:* Demonstrating the ambition as a city provides incentives and influence on business development of companies (e.g. in terms of upcoming demand for replacement and new buildings). Main driver are big costumers, e.g. a city with only 26.000 light points compared to a capital city with 2-3 mio. light points has a completely different standing and purchase power
- **Customer needs:** What do customers want and find relevant? Pilot projects have different focuses in different cities due to local experiences and preferences (e.g. political interest like dynamic school lighting in Malmö, personal security in Stavanger)

Monetizing Benefits

- **Measuring benefits:** It is crucial to develop metrics to measure the benefits. For example the effect of a Light Festival can be calculated by measuring the increase in hotel nights booked. It is more challenging, but very important, to measure improvements in health and wellbeing.
- **Life cycle costs:** When deciding what is to be considered green, we need to “extrapolate” into the future, since we are dealing with LCA over long life-cycles, where conditions may change over time. The technical performance and efficacy is improving very rapidly and new things may be found to be problematic. From Life Cycle Cost, LCC point of view it is crucial to take a handle on the distribution between different departments (landlord–tenant)
- Investments in more advanced systems and lighting can support branding to enhance the **city’s identity and the image as an attractive place**. The cities investment and maintenance cost for lighting was estimated to be in the order of 2-5 €/citizen (not including electricity). Lighting is a **very cost effective tool** to make the city and very many kinds of buildings more attractive.
- **Targeted investments:** When investments are made, they lead to maximum benefit and political support when they address specific local needs. Therefore systems and solutions are required to cooperate with citizens in order to learn from their behavior and to collect data (e.g. how many people would use improved solution, timing etc.)
Example (Espoo): City square at night, where most people cross diagonally. Light could invite people to stay at the square in the afternoon.

Example (Stavanger): Walkways by night offer increased personal security (e.g. to prevent rape and crime). Information on incidents (e.g. number, location, day time) will increase shared value of better lighting

Smart City Functions (transport, buildings, energy, water, government)

- Most interesting: Smart Transport and Smart Buildings (Stavanger point of view)
- *Example Stavanger:* Light pollution from light outside of the buildings shining into apartments. A lot of discussion about fixing light to the walls of buildings and the need to find solutions to minimize light pollution. This is a hot topic for city planning in dense areas, which originated from the political level. There are also other more complex issues.
- Less interesting: Smart Water, Smart Government, Smart Energy (not in this project, but related; need to be aware of the relations between different smart city systems)

4.4 Resulting starting points for Green Business Development

The workshop and survey outcomes have shown multiple areas for application, encountered bottlenecks as well as untapped potentials. The presented mapping is intended as a toolbox that the project participants shall be able to use to build broader interest in Green Investments in and Green Business Development for advanced SSL-based system solutions.

Possible starting points are:

- Tripe helix stakeholder and citizen engagement: Identify complementary needs within your own city to create synergies and therefore make new solutions more desirable through an increased shared value.
- Seeing is believing: Potential customers are hesitant to invest as long as the appreciation of enhanced results and higher values is unclear. Risk-sharing as well as political leadership can help to overcome this barrier in order to make experiences with visible pilot projects to serve as driver for further development. Honesty and openness is crucial to built common ground and trust.
- There is no fixed recipe for the lighting of the future. To be able to significantly enhance the level of customer value it is vital to get going with experimental installations of more advanced lighting and living lab activities as a base for mutual learning.
- Branding with lighting is a cost effective way to create attraction and enhance the identity of the city.
- It is important to develop the ability to measure new light values
- The solution needs to be open and flexible. Open can refer to a) open access, b) open development platform/flexibility, and c) the use of open standards. Important criteria for the solution are security and robustness. Personal integrity is a very important issue.
- It is better to start with a well functioning platform with some functions, than to start with a lot of functions and have problems due to complexity. This gives the opportunity to learn and see in which ways people use the solutions, or not use them. (Comparisons could be made to the thinking about minimum viable products.)

5 It is vital to show significantly higher value

To get going with disruptive market development it is essential that the new “product”¹ is perceived as considerably better, compared to the present products. Otherwise the sales of the new products get caught in price competition with the established products, and then the difference in performance tends to be neglected in the selection of supplier. To be able to fund innovative development it is vital to be able to get a higher price.

The need to show some kind of significant improvement is crucial in relation to the ambition to accelerate the deployment of more advanced SSL-based solutions. It is quite common to say things like, “LED is very much better than the traditional lighting”. But then the description of the new light sources tend to get caught in defending that the light from the LED products is almost as good as the light from the incandescent bulb.

Smart city ICT systems provide potential as tools to overcome this shortcoming. However, the presented review of the present level of business development level for smart city systems indicates that also the descriptions of these applications hitherto focuses on the ability to deliver the same level of societal service as before, “only” in a more efficient way. The report hardly mentions any new considerably higher level of value creation and in my understanding the presented picture is correct (unfortunately). And to be honest, also smart city solutions are struggling to take off on the market.

When looking from a sustainability point of view, the noticed and described advantage of both Smart Lighting and Smart Cities tend to be limited to energy saving and Life Cycle Cost saving potential. However, this is only a secondary aspect from customer value and business development point of view. The most important aspect is that investments in Smart Lighting and Smart Cities has the potential to enable significant improvements of the working and living environments in cities, preschools, schools, offices, hospitals, cities and traffic, not least for persons with special needs and all the elderly people that need better functionalities to reduce risks and enhance quality-of-life. The growing interest in those improvements will generate a large market for considerable entrepreneurial business development and green jobs. This positive potential is hardly mentioned.

The ENIGMA PCP process enable the involved cities to take the role of lead users, interacting with clusters and suppliers, including ICT companies, to gain early insights that enable value creating and branding advantages by early high level utilization of SSL. This serves as a stepping-stone towards creating a market for Smart lighting and Smart City Systems, where all sorts of customers and suppliers are involved. The stepping up of volumes will enable and motivate innovative business development for solutions that provide superior value-for-money offers at a higher value level.

It is crucial to develop solutions that are both environmentally sound and economically viable. Products and business activities that cause accumulating environmental degradation will sooner or later face market problems. Products and services that cannot be made profitable are of little consequence in the market evolution.

The key to get going with radical business development is to create new functionality, which provides a significantly higher level of value, both within existing, as well as for totally new, application areas. By focusing primarily on the creation of sustainable customer value there will be new business opportunities. In a way this can be viewed as the development of premium market segments with a higher willingness-to-pay.

¹ The concept “product” here includes services and smart system solutions.

The conceptual challenge with need and possibility to create positive synergy between higher functionality and better cost-effectiveness is an important discourse in sustainable business development.

One background that hampers the ability to get going with a more sustainable development is that environmental adaption and also sustainability still ordinarily is conceptualised as an add-on. First the companies develop their products and then they make environmental improvements. To get out of this entrapment, sustainability has to be core business. At the strategic level, in leading future-oriented companies, at least in Sweden, this kind of understanding evolved in the mid 1990'ies (Karlsson 1998).

To get going with disruptive development, it is normally necessary to make considerable investments, i.e. to mobilize resources. One example of a person that is taking a stance in this respect is Erika Karp, one of the financial world's most powerful women. One recent article about Erica had the title "Stop talking sustainability" (Bederoff 2014). To make things happen she wants to "Accelerate the Velocity of Money" (Roston 2013). This illustrates the present thinking among some leading persons in the financial world.

The reason why this is interesting from financial point-of-view is that solutions that combine present business advantages and long-term sustainable development potential are better from investment point of view, see figure 8.

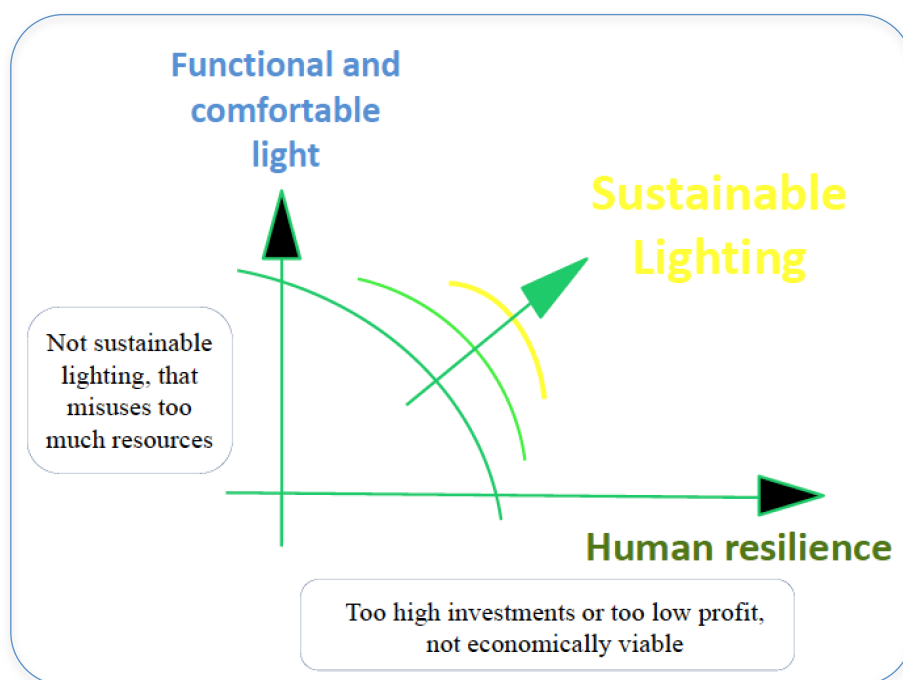


Figure 8 The field of development that combines attractive lighting and resilience. The vertical axis shows the business outcome, production of value upward and cost downward. The horizontal axis shows resilience, a basic sustainability advantage to the right and negative sustainability effects to the left. Solutions in the 2nd quarter are not sustainable and solutions in the 4th quarter are not economically viable.

To understand the foundations for this line of thinking it is interesting to look into the starting points for the sustainable business development discourse. One paper that created early business awareness about the potential of these synergies was *Green and Competitive* (Porter 1995). A similar line of thought is further elaborated in *Factor Four: Doubling Wealth, Halving Resource Use*

(Weizsäcker 1997). It is about effectiveness, i.e. doing the right things. Efficiency: doing the (same old) things right is not sufficient.

The need too make more people truly interested in significantly higher customer and user values applies for both Smart Lighting and Smart City Systems, and it is feasible for both. The combination of both perspectives enhances the odds to attract attention. However, it is essential to present more significant and noticed enhancements of the level of user value. It is not sufficient to integrate with additional volume on the same value level, even if it is both lighting and systems.

Furthermore, the precautionary principle is stressing that it is important to start to take appropriate action, as soon as there are reasonable indications. Lack of complete scientific proof is not an acceptable reason to wait before taking action.

The key to radical innovation is to significantly enhance the customer and societal values.

6 Conclusions

SSL and ICT enable a completely new level of potential to make dynamic system solutions that provide the right light, in the right place, at the right time. There is very large freedom of action for new business ventures. This is a great opportunity for Intelligent Green Business Development. However, there are also risks that primitive cost minimization results in solutions with such a low customer value that LED and energy saving projects gets a negative reputation. The technology of today offer enormous flexibility and it is crucial to deploy it in a wise way.

The prefix Intelligent in “Intelligent Green Business Development” has two main connotations:

- Intelligent system solutions, to enable better customer value in a more effective way.
- Intelligent ways of working, with sustainable development as an integrated part in the core of the business and solution development. The key is to make the sustainable solutions more attractive for users and customers.

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WP D2.2. Appendix I: Notes from Interviews and Discussions with selected Experts (Topic: Green Business & Positive Examples on SSL)

Jan Ejhed, KTH STH Lighting Laboratory, conversation from 11/12/2013

- Quality is much more inspiring starting point, not focus only on energy efficiency
- Positive example: research project issued by Trafikverket about tunnel lighting
- Positive example: pedestrian pathway in Stockholm, investigation of how to control the lighting and how visual and safety conditions are affected (master thesis)
- Measuring is simple, but to interpret the meaning is difficult, e.g. the tunnel kept the visual conditions but decreased the brightness
- Challenges: education attitude, knowledge
- Is new technology trustful? as person from the municipality I hesitate to introduce new ways of thinking, new technology since new factors are not easy to calculate
- By the same time high interest from municipalities to learn about it
- Municipalities have the new technology but they are specialist in electricians but not in electronics! There is a very big component in electronic management, but they don't have the knowledge by now
- To get the relevant information how it really works is the keypoint and the threshold
- When there is general knowledge that it really works the development will come very fast, but we are not there yet, nobody want to make a bad investment
- Positive example: EU project "LED in Public Spaces" on LED light as alternative in an ordinary small city (retrofitting, road safety, different quality measures in different places)
- Workshops are a good initiative, because you have the possibility to talk to people; data you get everywhere, but talking is more relevant
- Every company can distribute facts and the consumer will not trust these
- Qualitative statements are better than quantitative ones, argument and distribute!
- We talk a lot about these things, but we don't have the real knowledge to HOW to do it
- We need to understand the context and how we are working in the context

Alexander Weiland, Aaxsus AB, conversation from 16/12/2013

- Light color has positive effect on human well being (e.g. red light: more awake, blue light: more tired, white light: helps Alzheimer's disease)
- Need for further research, not only color but also on exact frequencies of light and its effects
- Development of light control systems to adjust light properties automatically to desired effect (e.g. when the class room is very noisy automatically adjust to more calming mood light). Company providing solutions e.g. www.moodifier.net
- Problematic issue: Research often aims to attract new funding (e.g. by Vinnova) instead of developing new solutions
- School tests have proofed that students are less tired when flicker free LED was implemented
- Tests require extensive knowledge and diligence, e.g. test on LED lamps for surgery failed since the light frequency had the same frequency as the electric knife (both 100.000 hertz) and therefore the undesired effect that the knife seemed to stand still
- Street lighting not a suitable example as still the price is considered to be the most important

Bogdan Tudosoiu, CTO of Mobile Heights, conversation from 16/12/2013

- Company mobile heights discusses the drivers for lighting, e.g. try to drive light on the street and indoors; building modules to control; Bluetooth will be the driver; all needs to be compatible
- Most companies have a vertical approach and need a more horizontal; they look mostly how to comply with standards instead creating new business opportunities; the disruption will come from ICT side
- “green” is mostly boring, the business models will emerge from improved usability, internet of things, and will come from top down and not bottom up; e.g.
- Other disruptive examples: AirBnb, Car-to-go, etc.
- people and their disruptive ideas will set standard and trend; companies will buy them out
- Example NEST thermostat: wireless technology in a product that already exists, copy/paste and improve and give the solution a new speed, and therefore a new business opportunity

Erik Wikström, MD of Nordic Light, conversation from 11/12/2013

- Not many technical barriers left for LED lighting, except dazzle which is mostly regulated
- A major important issue is energy consumption (economically for the community)
- Maintenance on the green side, but more troublesome outdoors than inside, therefore automated communication control system to signal need
- For more collaboration light manufacturer, IT expert, customer needs, software etc.; for SME it is risky and costly to develop these systems
- Comparison of EU and Korea, there you get 20% back from the government if you use LED
- Example Japan: in order to reduce energy costs by 20% (25% for retailers), they take away 25% of the fixtures instead of changing to LED
- Main driver are big costumers, e.g. a city with only 26.000 light points compared to a capital city with 2-3 mio light points has a completely different standing and purchase power

Mats Bodén, Bioinspired Forum, conversation from 10/01/2014

- Open innovation and public procurement is a problematic combination due to unsupportive existing structures; entrepreneurs risk a lot while civil servant don't; need for structures and procurement processes where all players are equal
- Driving force: public sector is an enormous market
- Working on that entrepreneurs help innovators to have test beds and develop their ideas
- When it comes to light people follow a more academic approach and use more semantics; but when the innovation is deployed we need a language that does not say they want to sell a light bulb; we need a completely new language, it is more about communication and social media; we are entering a phase that is a new era.
- e.g. the Swedish term for lighting “belysning” describes light as something passive, but the media light has so many (new and different) dimensions

Sofia Traneflykt, City of Malmö, conversation from 09/01/2014

- Outdoor: streetlight is an important application area, both for safety and to light up the public spaces.

- Indoor: Mood lighting is an interesting aspect of the SSL application, especially in schools where the lights should be able to help and support students in their learning.
- New areas in Malmö for implementation is the extension of Västra Hamnen and Hyllie
- Malmö tries new things and acts as sustainable city, but the main challenge is the investment, if new solutions are too expensive it can be an issue; lifecycle costs and benefits for society are major things to consider; the city also follows what investors order

Marc Fontoynt, Cluster Lumière, conversation from 09/01/2014

- Creating opportunities that will promote a disruptive technology; the disruption will change the value chain structure, more complexity from production to installation, more B2B
- Experiments in hospitals were positive;
- Interesting application areas: indoor lighting, airports, railway stations; pedestrian areas are of high interest, streets street furniture (e.g. busstop), bridges and façade lighting.
- Other areas of experimentation and application: military and astronauts (sleep rhythm)
- Energy savings is not the driving force and a 10 year life expectation is no argument in a constantly changing market
- Revolutionary is the cultural expectation and the IT technology behind, not the SSL technology
- Interesting for business opportunities is what we can offer addressing the human perception of light (e.g. What kind of meeting room or subway do we want? Provide an experience and not just a lot of light!)
- A good model is extremely efficient and by the same time extremely good, since the actual energy costs are quite low compared to other features
- A priority for cities is to identify the lighting costs per year and the budget for lighting
- To work on city lighting might be a political challenge, but cities must work on their identity and lighting is an important aspect
- Try to create a change from supply to demand! promote an upstream financial model
- The market is the key (not the technology)
- Brands are important to create confidence for cities

Rüdiger Ropinski, City of Rietberg, conversation from 13/01/2014

- Winner of competition “Municipalities to shine in new light” and gained 2 Mio. EUR 100% funding for the installation of a LED master plan for the historical city centre
- The City of Rietberg has a strong sustainability vision and has already planned to switch completely to LED before winning the grant. The grant accelerated the installation within the city centre, the refurbishment of public lighting to LED in the remaining parts of the city (indoor and outdoor) is in progress.
- Challenges: Alignment work with monument protection, private ground owners, but processes without problems since solutions were connected to public grid or energy consumption was compensated
- Advantages: DIN norm street lighting, better face recognition; evaluation including public survey in cooperation with FH Bielefeld; outcome positive, except few considered light to be too bright

- Project was kick off, political decision for city wide LED rollout; city is pioneer in climate protection
- Tourism is important factor, since city has only 30.000 inhabitants
- LED solution for visually impaired citizens
- What can other cities learn? rapid payback, very important: giving the city a nocturnal face, city branding
- Recommendations: to work with experienced solution provider; e.g. 5 years warranty

Franz Bühler, City of Freiburg, conversation from 13/01/2014

- Motivation to participate in the competition “municipalities in new light” was 100% grant (which is very seldom), new lighting for the cathedral of Freiburg was planned
- Interest existed in LED technology, but regarding existing risks the promises need to be proven first; due to current prices the switch to LED would not have happened before 2015 in order not to take the risk
- Company HESS is cooperation partner to provide the technology, the City of Freiburg provides the infrastructure
- Project included new luminaries and also retrofit
- Highest perceived risks: that the indicated duration of 50.000 hours lighting will be less
- Accomplishment of the project in the end of 2012, warranty of 2 years, what happens afterwards will be in the responsibility of the city
- Example: spotlights on the ground (to lit the cathedral) were prototypes and developed condensed water, problem got solved and improved by Hess
- Hess is high quality provider, however got insolvent during the project due to issues with the board and had to switch from stock company to be run as a limited company, warranty was maintained and cooperation went on well
- Challenges: work intense, regular meeting with the monument protection office, test lighting procedures, new lighting locations on private ground, therefore completion of the project within 2 years (to obtain 100% grant) was challenging
- Lighting according to DIN norm is required; therefore Freiburg decided to change another 200 light points (mercury based) to LED (by now city centre on LED which is 5% of entire city); otherwise LED will be implemented where financier/ funding is available, otherwise high pressure sodium lights (HPS) will be installed
- the city is obliged to guide interested groups and individuals and inform about the project for 5 years, but so far little request for this service
- in terms of maintenance, the long life of SSL (here expectation of about 12 years maintenance free) is not a main argument, since electrical maintenance has to be done every 4-5 years and therefore work on street lighting needs to be anyway
- main quality improvements: targeted lighting against light pollution and better ambience, especially valuable for dense residential areas where living areas are close to each other
- Recommendations: don't use cheap products but use SSL from high reputation brands, consider weather to exchange the whole lighting solution or only parts in case of damage
- overall satisfied until now, LED technology especially supportive for the “green” city agenda

Mark Rea, Lighting Research Center (LRC) at Rensselaer Polytechnic Institute, Troy, New York, conversation from 17/01/2014

- In previous times, lighting meant to fill sockets; e.g. to take existing lighting infrastructure and use light bulbs. This picture dominated the industry.
- SSL changes this picture since you don't need a big investor. People try to bring it back to a commodity business; this has not worked out yet but is in progress.
- The thoughts to focus on the numerator are not new, but nobody cared so far and therefore a socket filling business was dominant.
- When you do workshops, people use the term *quality*, this statement could be everything. The metrics are not everything, but it is a movement from lm/W to new metrics! The most important thing is to engineer brightness instead of candles.
- We have tools necessary to engineer the solutions and to measure, you can do this without having an artist or designer to deliver better lighting.
- In a workshop people should talk about the progress to collectively get these metrics
- Example Medicine and Lighting: In healthcare a doctor can measure health, while in lighting you hope for the best but you don't know. Medicine took a long way to develop metrics, measure and give good treatment.
- Example project in Stockholm: Daysimeter device to measure light exposure of a person; just finished a study in Stockholm including summer and winter, a lot of opportunity for interaction between lighting and health.
- Positive example: Brain institute in Amsterdam, positive results in better sleep in institutions; Mariana Figueiro is a key researcher in this field.
- Positive example: Gather data about the behavioral patterns of school kids. They might perform best at school but not if they find the conventional light situation at home, then the positive effects are gone. The full light exposure (day and night) needs to be known and considered.
- Example: US navi submarines and promotion of sleep
- Municipalities are focused on the investments. If you e.g. reach a community with many seniors that express certain needs, or a community with incidents on a crosswalk, then you know what a city cares about.
- Example: Color. Everybody competes on price and industries with very good ideas can improve the color rendering. If you want to have a disruptive technology, new companies come and compete on price. So better don't just compete on color, but brand your company for engineered solutions, you need several ways to communicate your value proposition.
- Big companies (referring to illustrative example of Budweiser brewery) want to stay up with the trend, they e.g. bought brands and successful micro breweries to be on top of the trend, but in the end they maintain their core business.
- Advice: Bring ideas into society and openly talk about it!

Paola Belloni, Steinbeis Technology Transfer Center - Lighting and illumination technologies in Freiburg / LED-Netzwerk Schwarzwald, conversation from 21/01/2014

- Positive example Freiburg: better light color (technically measured), better acceptance by citizens, better face recognition, better rendering
- Technical controlling with intelligent control systems; municipality staff needs to have technical know how in order to manage the systems

- Within the innovation S-curve we are currently in the first slope of the curve, the city has to create a concept and engage citizens
- Main challenge: generally, almost all cities that have worked with SSL had problems with the lighting manufacturers and solution providers → therefore very important: the masterplan planner and solution provider must be completely independent to ensure a high quality standards
- Public funding goes into public lighting, many manufacturers do not have the competence to manufacture everything themselves and therefore need to buy parts and do this often on low cost → quality assurance is important
- Gets often requests which manufacturer to exclude (in contrast to recommend providers)
- For architectural planning: Professional Lighting Designers' Association (pld-a.org)

Niels Carsten Bluhme, Albertslund Kommune, conversation from 21/01/2014

- Albertslund as a suburb of CPH was built within 8 years, now after 40 years need for refurbishment of housing areas with a huge potential for upgrading (60% total on renovation); need to transform jobs; 2 bn EUR programme within next 6 years
- Lighting system is 40 years old and needs update because of storms preferred underground solution, thereby system got disconnected from electricity companies to take it back to the city
- Shift from traditional to new technology, Albertslund became part of photonics research and got the understanding of SSL to be the GATEWAY to the smart city and a smart city environment
- In order to have better business opportunities it is necessary to upgrade the competences; need to increase and upgrade the competence in the city, tripe helix
- Demand side driven activities run by cities in Europe is a main way to accelerate! important to work together; using municipalities to buy capacities and giving access to the municipality as a living lab
- Started to engage in clusters and networks, topic got high importance for infrastructure, got extension to Danish lighting innovation, Denmark needs to take the lead; it changed from a local city agenda to a national agenda
- Northern Europe will become very strong hub for nano, demand side driven; the municipality is important part how to gain global competence and compete globally; get businesses to work closely with the municipalities; cities need to collaborate; Albertslund has broaden stakeholder engagement to ICT sector to create infrastructure (e.g. IBM; Cisco)
- Recommendation: political acceptance that you accept the city as a living lab, to use the means of society in a better way for transformation, take a risk and it has to be political leadership



Appendix II SSL-erate WP D2.2 Pilot Demonstrations and Case Studies for SSL



PLEASE NOTE:

In this research for examples we have been looking for a variety of positive examples that indicate significant improvement from user point of view. No scientific evaluation has been done on the actual representativeness of the statements found.

2

Project Locations and Origins



Project Examples

„LED in Public Spaces“,
EU Project, South Baltic Region, 2009-2012

„Municipalities in New Light“,
Competition by German Government 2010-2012

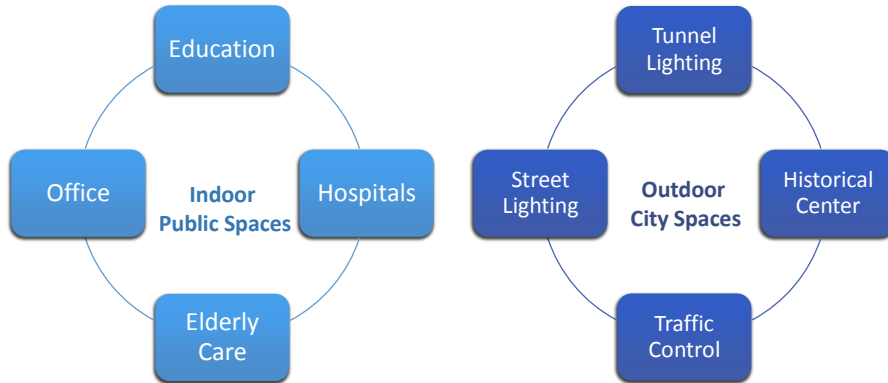
„Lighting the Cities“
EU Commission 2013, European Cities pioneering SSL

„LED Projects And Economic Test Cases In Europe“
EU Commission, 2012

„Plus Mainstream Guide – Guidelines to cities on sustainable public lighting strategies“, PLUS, 2012

... and many others

Application Opportunities for SSL



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Examples - Innovative SSL Solutions

Example		„Conventional“ Benefits			„Human-centric“ Benefits					
City	Sector	Energy Savings	CO2 savings	Cost savings	Personal Security	Health & Wellbeing	Productivity / Learning	Light pollution	Driving Safety	City Branding
Tilburg, NL	Street Lighting	86,2MWh/y y 26.3%	n/a	92.000 €/y	X				X	
Freiburg, GER	Centre / Street	60%	67 t CO2	n/a	X			X	X	X
Rietberg, GER	City Centre	50%	29 t CO2	117.000 € /10 years	X	X		X	X	X
Trier, GER	School lighting	89 %	0,63t/y;5 7%	n/a		X	X			
Oskarshamn, SWE	Bicycle road	2361,45kW h/m.	n/a	204,87 € /month	X	X			X	Tourism
Madeira, Portugal	Tunnel lighting	35%	n/a	€1 000 /month					X	
Lyon, France	Bridge	50%	n/a	n/a				X		X
Malmö, SWE	Schouten Bridge	810 kWh/y	n/a	Paypack 12,5 yrs	X			X	X	X
Copenhagen, DK	Offices	2652 kW/y	n/a	250 € / year		X	X			

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5

#1: Education & Productivity



- **“In der Alten Forst“**
Dynamic school lighting
Location: Hamburg, Germany
- Communicated results:
 - 35% increase in reading speed
 - 45% drop in frequency of errors
 - 76% reduction in hyperactivity
- Study on same issue: Focus lighting led to a higher percentage increase in oral reading fluency performance (36%) than did control lighting (17%).

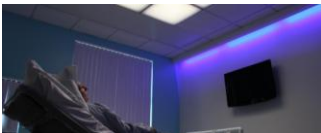
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6

#2: Health & Wellbeing



- **Care for dementia patients at Bradford Royal Infirmary**
Location: Bradford, UK



- Lessons learned:
 - “In addition they have carried out an evaluation and the patients are definitely calmer and happier. It is a very good example of using knowledge and experience to create a very human environment.”
 - Building Better Healthcare Awards 2012 - Winner “Best Interior Design”

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#3: Health & Wellbeing

- **“St. Katharina” Improved quality of life for resident dementia patients**
Location: Vienna, AU



- Lessons learned:

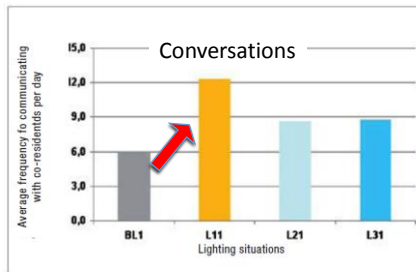


Fig. 5-10. Average frequency of conversations – average of all residents per day in the various lighting situations

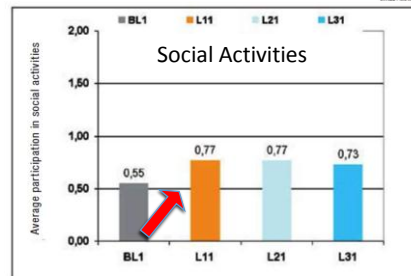


Fig. 5-16. Average participation in social activities during the lighting situations in the first run

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4: Personal Security & Wellbeing



- **„In the Shade“ –**
Make neglected corners more livable
Location: London, UK

- Lessons learned:

- Diffuse, distribute and target light to people
- Consult, listen and engage with users
- Give the urban realm its own characteristics

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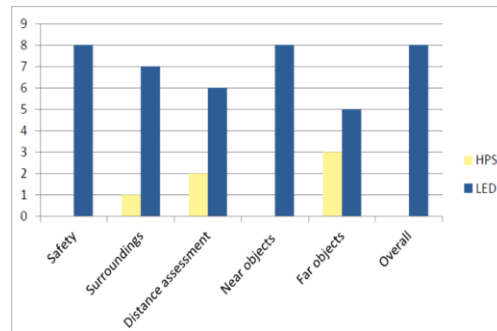
#5: Traffic Safety

➤ **Lighting Häggvik Tunnel – HPS vs. LED lighting (by Trafikverket)**
Location: Stockholm, SWE

➤ **Lessons learned: Better lighting in a tunnel regarding perception and energy efficiency**



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10

#6: City as a Living Lab



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➤ **From municipal refurbishment to national movement**

Location: Albertslund, DK

➤ **Lessons learned:**

- SSL = **gateway** to smart city development
- Smart city = **more value for money**
- Political acceptance and leadership
- **Make a difference** up to national level

11

#7: Communication Services



- **„IntelliStreets“ at Henry Ford Health Systems, Detroit**
- Benefits of pilot installation:
 - Providing audio & video messaging
 - Enhanced safety
 - Defining closest parking spots
 - Dimming building lights when not in use

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#8: Wellbeing & Security



- **„Municipalities to shine in new Light“ Case: Rietberg, Germany**
- Benefits of SSL solutions:
 - Giving Rietberg a „nocturnal face“
 - Guidance for visually impaired citizens
 - Tourism (only 30.000 inhabitants)
 - LUCI „city.people.light“ Award 2013

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#9: Historical City



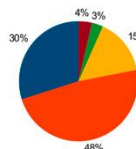
➤ „Municipalities to shine in new Light“ Case: LED Master Plan Freiburg, Germany

➤ Lessons learned:

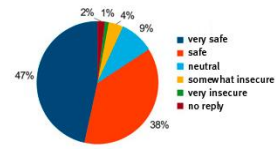
- Alignment work & time planning
- Importance of high quality
- Independency planning & provider
- **Benefits:** 60% energy & 67t CO₂/y savings

How safe do you feel?

Before the change



After the change



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#10: Branding “Cities of Light”



➤ Lyon, France

- “Lyons changes by night: it is facinating, giving the city a soft and elegant beauty.”
- “At dusk, Lyon is luminated and **stands out**”



➤ Jyväskylä, Finland

- “Lighting is a central element in **Jyväskylä's city identity**”
- Awarded for its “outstanding utilization of city lighting for the development of a sustainable city environment”



➤ Eindhoven, Netherlands

- “Light in Eindhoven has to have meaning. It is not just functional but is also related to **imagination & emotion**.”

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Benefits in Economic Test Cases



JRC SCIENTIFIC AND POLICY REPORTS
LED PROJECTS AND ECONOMIC TEST CASES
IN EUROPE

Executive Summary

LED is a fast developing, promising technology, offering a wide range of potential uses. This report presents the status of existing LED pilot actions in Europe, analysing 106 LED test cases from 17 European countries. Projects from the public and commercial sectors form the focus of the report, with special attention devoted to the economics of LED projects.

The results of test cases demonstrate wide variation. Installations offer energy savings of 59% in average (savings range from 10% up to more than 90%), either compared to the original installation or to reference consumption. In many applications, LEDs are competitive (with payback time ranging from 2 to 10 years), yet a large number of projects are still in the trial phase. In these cases, economic aspects are relatively less relevant, and are often not even accounted for (as economic evaluation at this stage can even be a disadvantage).

7 Advantages and co-benefits

Apart from energy savings, the test case reports often highlight "soft" co-benefits, which add to the potential of energy savings. These co-benefits include, among others:

- road safety for traffic lights,
- no UV radiation,
- indoor and outdoor lighting quality, indoor ambience and atmosphere,
- the variability in design of LED applications, and
- environmental benefits.

These co-benefits (supplementary to energy savings) are rarely quantified, possibly hardly quantifiable, yet apparently perceived as very important by the customers. Often these are highlighted as the major benefits, outdoing the "direct" benefits of energy savings, which moreover, as mentioned above, may not be sufficient to cover the higher investment costs of the projects.

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106 LED test cases, 17 European countries (2012)

„Installations offer energy savings of 59% in average (range from 10% up to more than 90%)“

„In many applications, LEDs are competitive (with payback time ranging from 2 to 10 years)

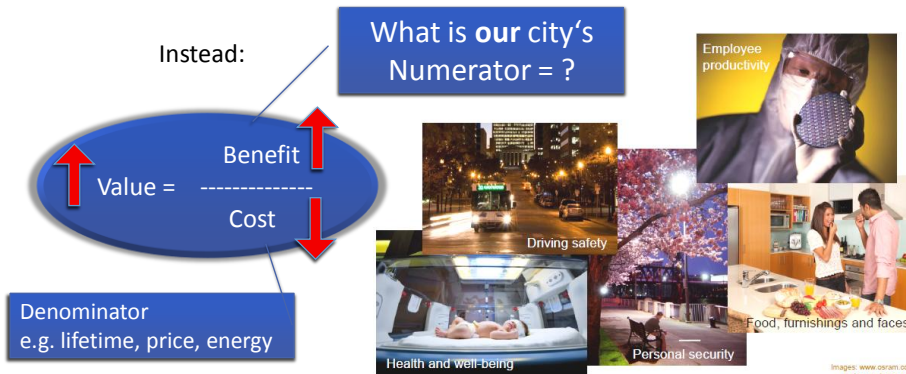
the test case reports often highlight "soft" **co-benefits** (that) are rarely quantified /-able

these are **highlighted as the major benefits**, outdoing the "direct" benefit of energy savings

Creation of Customer Value

Value = benefit / cost

→ Lumen dominated for decades as main benefit (**lm/W**)



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„Value Metrics for Better Lighting“ (2013) by Mark Rea

Thank you!



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Autoren: Prof. Dr.-Ing. habil. T. Q. Khanh, Technische Universität Darmstadt, www.lichttechnik.tu-darmstadt.de | Prof. Paola Belloni, Hochschule Furtwangen, www.hs-furtwangen.de | Prof. Eva Schwenzfeier-Hellkamp, Fachhochschule Bielefeld, www.fh-bielefeld.de

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www.bmbf.de | www.photonikforschung.de

Links:

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Franz Bühler (Dipl. Ing. FH)

Sachgebietsleiter Neubau

Garten- und Tiefbauamt

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Fehrenbachallee 12

79106 Freiburg i. Br.

Interview from 22.01.2014 with coordinator of project evaluation

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E-Mail: Paola.Belloni@stw.de

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Creation of Customer Value

„Value Metrics for Better Lighting“ (2013) by Mark Rea

Personal conversation with Mark Rea from 17.01.2014

Appendix III: Structured compilation of meeting notes from the workshop on Green Business Development

SSL-erate WP2.2 Workshop - Mapping of Green Business Opportunities

Lund University, January 23rd, 2014

The notes were kindly provided by several workshop participants and herewith compiled according to various issues mentioned. For the workshop, the participants were divided into 4 groups, the outcomes were presented and discussed afterwards.

Workshop group leaders: Pieter Jan Bolt, Nils Erkamp, Reine Karlsson, Håkan Lagerquist

Workshop procedure (described by Nils):

I first described the main drivers that people could consider

- *technology: easy to control light level and color with SSL, combination with ICT technology/connection with internet information, inclusion of sensor*
- *application domains: urban, work, care, education home*

People were asked to come up with ideas / possibilities.

The mood changed from 'how am I going to come up with any idea' to 'WOW, there are actually great opportunities'. Time was too short to finish it all; people started building on each other's ideas and were triggered into new ones.

III.1: Aspects to consider for the organization of local workshops

- Develop knowledge – create interest – create business ideas
- Need for the dissemination of knowledge and information around teams with respect to stakeholders
- Rename it accordingly and Clarify word « GREEN », e.g. in Norway „sustainability“ works better and „green“ would lead to misunderstanding
- Avoid false expectations
- Invite relevant stakeholders
- Address bottle necks (costs, quality, financing)
- People are not aware of problems they have with light
 - timing is an important issue (first spread knowledge, then show problem they haven't perceived as such before)
 - marketing innovation, risk sharing
 - locally identifying the stakeholders
 - sale function more than products.
- Workshops are about better value for money – but not only about cost saving, also about releasing non-monetary benefits.
- Organizing city: demonstrate ambition
- Information on SSL, beyond cheaper lighting; smarter lighting (leading to evidence based decisions once organizations / cities decide on aim)
- Organize around a theme, invite relevant stakeholders; address bottle necks (costs, quality,...., financing)

III.2: Opportunities in relevant Application Domains:

Urban

- Tourism / Enjoying the city
 - Tourist information
 - Festive lighting effect (e.g. a wave of light through the city)
 - Create guided light tour – include sound system in pole
 - Mark events/happenings in the city
 - Special lighting effects for historical week, industrial heritage, green city
 - Advertising: use light as a possibility to advertise products (earning model)
 - Light can be like a guide or assistant to find the right place
 - Way finding
 - Guiding tourists in/outside the city
 - Providing tourist information on historic buildings
 - Local guided tours.
 - Highlighting areas (distinguish between new and old buildings, e.g. Bassano)
 - Art projects:
 - Art projects with e.g. local artists. This could be very interesting.
 - Music and sound.
 - Light art – dynamic social inclusion
- Ambience:
 - No outdoor lighting at all to see the stars without light pollution
 - Create a different day and night view for the city
 - Light can be useful to enjoy green place/park better than now with different function
 - Community designs lighting e.g. as artistic exhibition
 - Mood lighting with social indicator function in e.g. park: I want to be alone, date, play, ...
 - Adapted to the natural light (snow and sun, etc) and to the colours of the season.
 - No people, no light.
- Traffic /Streets
 - Green wave guidance for vehicles towards traffic lights
 - Guide traffic at road deviations
 - Providing information regarding parking spaces
 - Urban furniture
 - Street lighting
 - Dimming when inactive
 - Light is already used as information (e.g. traffic signals/cars) → with colors this can be further developed to improve traffic
 - Traffic guidance link with GPS
 - Guidance without GPS for pedestrians and bikers
- Security
 - Alarm lights in case of screams or burglary
 - Security and alarms. Rape alarm is important and also politically interesting (Stavanger). People are afraid late at night. It could be used everywhere and e.g. light up an area with an incident etc.
 - Security lighting to feel more comfortable
 - Enhance security: in the streets, in the transport for drivers
 - Behavior: use light to influence the behavior of for example hooligans
 - Increased light for people with impaired vision.
- Sports:
 - Sport: tracking of street lights so you can do (interval) training

- Gaming: use light to invite children to play on the street
- Airport
- Stavanger searches to be more specific. They want an open system where the lighting can be controlled, and additional benefits can be added to the platform. Better lighting for walkways could lead to more possibilities than light.
 - Examples:* Interaction, Apps, etc. The pole could be used for:
 - Access to electricity to charge cars, phones etc. Apps could be used for payment.
 - Maybe for hotspot for wifi.
- The enhanced value that smart lighting solutions could bring for Bassano should increase the attractiveness of the old city; one could think of way-finding (guiding tourist in/outside the city), providing information regarding parking spaces or providing tourist information in relation to historic buildings.
- This brings Bassano's perspective to two target groups; solutions for tourist and solutions for citizens. These perspectives could sometimes be time- or season-dependent.
- Light can help citizen to have good service (public and commercial)
- Light can be used to know the story and function of building and urban places. Data about pollution or best practice in use

Work / Offices

- Light in shops – guide customer inside the shop
- Light to make a more comfortable working situation – do more in less time
- Personalized light at any workplace (even in flex offices) on basis of actual task
- Safety guidance to emergency exists of first aid kits
- Light that anticipate tasks on basis of actual presence
- Level and colour of light adapted to the area (meeting room, coffee, workplace), number of persons
- Rooms with type of light depending on the type of work. Concentration, team meeting, lunch time
- Beyond energy usage; increased well-being at work (productivity).
- Aspects: using dynamic / static lighting; creating ambience, contextual setting; complying to (upcoming) regulations on minimal light exposure; adaptable, interactivity by sensors, dimming cut off.
- Bassano: introduce innovative light in old offices, allowing higher light level in rooms with e.g. old paintings/art (less damage); same for museums. Bottleneck: current regulations may hinder diversion from current practice

Education

- Light to structure class lessons, days at schools, (can be used in hospitals as well)
- Light can be useful for learning also (at school and like tool at social building)
- How can light activate bored kids
- How can light cool down an overly busy/noisy class
- School renovation; contact with teachers and school children is important. In Malmö hot topic, large project to improve educational standards, part of which is better school buildings, including (new type of) lighting (system). Should be of interest for industrial partners: living lab in education & to show they can come up with green solutions and provide these. Project concerns 25 new school and 90 new pre-school buildings.

Care

- Guidance in complex buildings like hospitals, airports, university campus
- Elderly care homes; e.g. in NL private, in Italy: also private. Norway: municipality. Twenty four hour situation; conflicting demands residents / patients and staff. May also apply to prisons.

Home

- Sensors check whether residents are still alive and switch alarm light on as signal for neighbors to check
- Indoor programmable lighting to existing mood or desire
- Automatically adapt color and level of lighting to the activity we are doing. Very low level when there is nobody or festive. States: empty, resting, reading

III.3: SSL Green Business - Challenges and Opportunities

Value creation, Cost-Benefit, ROI

- Better value for money: workshops are not only about cost saving, but about releasing non-monetary benefits
- Changeable light color one of most interesting added values
- Real and nice demonstrators (show that the project has delivered value)
- Lifetime of a system
- Connection with smart systems and sensors (internet of things); Link of system to internet
- Relevant information on SSL: beyond cheaper lighting; smarter lighting (leading to evidence based decisions once cities or organizations decided to aim)
- Classification of possible installations and clarification where SSL can create highest benefits
- Value addition
- SSL is here, Colour can be changed (most interesting aspect), Lifetime of system .
- Cost of lighting for cities. Maintenance: 3,5 € to 10 € per inhabitant, 50% electricity for public lighting, 50% for buildings.
- Lyon Master Plan has been subject to estimates, but very hard to assess.
- How do you scope the ROI? Which parameter? Difficulty : nobody has described which impact light has
- Existing evaluation of lighting: cost effective tool to improve the city environment!
- *Ghent lighting masterplan award*
 - *consequences unknown*
 - *is there a way to measure?*
 - *possible to separate the effects of city branding?*
- LUCI: Light festivals; In Lyon impact was assessed: train and air travel, hotels and restaurants.

Branding:

- Many municipalities expect a return on investment in terms of image, standing and to become attractive
- Branding the city: branding leads to attraction
- Identity: local solution / image
- Competition between cities /emotion
- LUCI : Night paths, Innovative new way to light cities at night

Product & Business model innovation /expanded offering

- LCA: How do you compare “green”? Need for measures, EPO etc. Several layers: a) social, b) societal, c) technology, d) political.
- Consider input from WP 2.1.
- Need a comparative tool: a) environmental & b) higher value (i.e. both sides). What exists? Make one, if existing are not good enough. This will trigger business development.
- In order to make things happen now, we cannot wait for comparisons, but need to work in parallel. LUCI has a best practice database.
- Smart lighting, part of green. Need smarter than green. Bassano’s use of light is a good example. Listen to the citizens. Visitors (tourists) seeing good lighting in one city, may want it in their own cities: the spreading of innovation. Need good showcases. Will lead to business opportunities.
- The solution needs to be open and flexible. Open can refer to a) open access, b) open development platform/flexibility, and c) the use of open standards. Important criteria for the solution are security and robustness. Personal integrity is a very important issue.
- The framework is to improve the quality of life.
- How to deliver the function, not the product? Deliver the light: be able to specify the different *qualities* of light. Smart lighting and smart darkness.
- Total LCC important.
- Service component of the total offering will expand.

Communication

- Need to teach society to think about light: increase awareness and then move stepwise towards action/procurement (e.g. awareness, interest, desire, action). Today many do not think of existing lighting solutions as problematic. Too many are happy with bad lighting. Now we bring a solution and along with that also the awareness of a problem.
- Timing is important. Now, demand cannot be met by supply (yet).
- Easier to communicate and develop cities than consumers in this area, initially, due to numbers.

Marketing innovation

- Find innovative ways of delivering the message of the product, to overcome risk aversion and find ways of risk sharing.
- Use the application areas that the cities brought up in the separate meetings during the morning sessions on January 22, for business development.
- Identify important stakeholders.
- Local application specific workshops could be arranged in other cities than the arranging city, in order to increase visibility to important stakeholders. E.g. could Eindhovens workshop be arranged in Rotterdam.

Functions

- Improve mobility: Lighting can make it more attractive to commute with train or bike with parking solutions. A clear ambition is to improve *combined* transportation, where e.g. bike and train are used together for commuting.
- Smart lighting can benefit the whole system.

Business actors

- This is not easy. Aalto University has good communication with SMEs and can probably help with this. Espoo's picture is that smart city applications are mostly coming from that sector.
- Companies in the oil sector may have relevant competencies.
- The city (Stavanger) has started a list of relevant companies, including e.g. Lyse Smart, which is represented in the workshop.
- Maybe sponsors could be brought in for the test project.
- Design (design & architectural offices, design labels e.g. Diesel in Bassano)
- Producers of high tech solutions
- Local businesses and players
- Building sector (facility management companies, caterers, furniture suppliers, cleaning companies, property companies of local councils (e.g. in Sweden)) → these groups are more and more involved in ownership and/or exploitation of buildings

Process

- There could be a role for involving citizens in the development, e.g. various user groups, people with impaired vision etc.
- The selection process needs a good interface between the municipality and the users.
- It is better to start with a well functioning platform with some functions, than to start with a lot of functions and have problems due to complexity. This gives the opportunity to learn and see in which ways people use the solutions, or not use them. (Comparisons could be made to the thinking about minimum viable products.)
- Planning normally involves citizens, but it mostly concerns lighting being too bright or too dim. Otherwise they are not unhappy with lighting and not too interested in the issue.
- (Stavanger) So far, the interest from the political side has primarily been about rape alarm, dim light, better light and energy saving. Citizens want light to feel safe and they can go to areas, where they would not otherwise go. The politicians will make this easier. The chairman of the city planning board gives the project full support.
- Example Norway: first LED rollout, then adjust to human-centric needs

Smart city areas (by Stavanger (in blue) and Espoo)

- Smart cities is a living conversation in Espo, in city planning.
- Systems to cooperate with inhabitants. Learning how to collect data: how many people, time etc. Learning lighting.
- Learn from big data from sensors is discussed in the city. This is the next step. An example is the city square at night, where most people cross diagonally. Light could invite people to stay at the square in the afternoon.
- Lighting goals are attractiveness and energy. Sometimes energy is competing with quality etc.
- Of the five smart city functions the most important ones are smart transport and smart buildings.
 - Smart transport:
 - signaling closed roads, charging;
 - Safety, Guidance, Better marked bike lanes.
 - Smart buildings:
 - Lighting of facades. The light that comes out through the windows is considered for the total impression. The cathedral and the buildings along the water are interesting.
 - Break-ins. Lighting could be used to signal where there has been a break-in and perhaps also to show in which direction the burglar went.

- Lighting for surveillance cameras.
- built-up area, excludes parks and streets
- Light pollution from light outside of the buildings shining into apartments. A lot of discussion about fixing light to the walls of buildings and the need to find solutions to minimize light pollution. This is a hot topic for city planning in dense areas, which originated from the political level. There are also other more complex issues.
- Smart energy: **nothing special.** //Smart energy: Not in this project, but related. Charging would fit. Need to be aware of the relations between different smart city systems
- Smart water: **flood control.** // less interesting
- Smart government: **security, energy of lamps.** // less interesting.

Further important issues:

- City to become a national frontrunner
- Demonstrate the ambition as a city for demand side driven approach (e.g. in terms of upcoming demand for replacement and new buildings)
- Need to convince other cities, outside Enigma, or SSL-ERATE.
- Don't confuse/mix the benefits of "lighting" with the benefits and gains through "SSL" (How to deliver the function, not the product?)
- The main challenge is that solutions will turn out to be too complex and too expensive, and therefore too difficult to get approved by politics. Good, well functioning solutions, with some good functions and within economical boundaries, is what is needed.
- Important is that any solution would have to fulfill local, regional and national legislation, which could potentially be restrictive to proposed solutions, as some of these regional requirements are considered to be the most difficult to fulfill in all of Italy (i.e. the dark skies policy; preventing of light pollution).
- The solutions space for the old city centre is relatively free, as there are currently no regulations that have prescriptive demands for this area (Bassano is considering this to be a problem).
- Massive marketing by manufacturers did not succeed as planned
- Need to compute long term effects of lighting; be able to compare different options
- Can we use new technology to face these challenges?
- Local development required
- Areas for business opportunities :
 - Need to make an inventory of what is available, what is missing
 - Need good demonstration examples
 - cities where people can come and watch
 - expanding services / complex offers
 - Review inventory from Enigma workshop
 - Need to teach society to think about light

III.4: List of Participants

Participants workshop 22-24 Jan Malmö/Lund				Participation		
Name	Organization	Project	Country	Wed	Thu	Fri
Jussi Lehtinen	Espoo City	ENIGMA	Finland	Yes	No	No
Hilde Uberg	Stavanger City		Norway	Yes	No	No
Anne Cecilie Lassa	Stavanger		Norway	Yes	Yes	No
Nils Henrik Haaland	Stavanger		Norway	Yes	No	No
Jarl Hoogstad	Stavanger		Norway	Yes	Yes	Yes
Ingjerd Bratterud	Stavanger		Norway	Yes	Yes	Yes
Olav Stav	Stavanger		Norway	No	Yes	Yes
Sofia Traneflykt	Malmö City		Sweden	Yes	Yes	Yes
Sanny Hell	Malmö City		Sweden	Yes	Yes	Yes
Johan Mattsson	Malmö City		Sweden	Yes	Yes	No
Jan Josten	Eindhoven	Enigma	Holland	Yes	Yes	No
Irmo Kaal	Eindhoven	Enigma	Holland	Yes	Yes	No
Arthur Noordhoek	Eindhoven	SSL-erate	Holland	Yes	Yes	No
Jaap Strating	Eindhoven	Enigma	Holland	Yes	Yes	No
Adriano Ferraro	Bassano		Italy	Yes	Yes	Yes
Roberta Michelin	Bassano		Italy	Yes	Yes	Yes
Paolo Montagna	Bassano		Italy	Yes	Yes	Yes
Marta Krakowiak	Bassano		Italy	Yes	No	No
Julia Gottwald	Hamburg	SSL-erate	Germany	No	Yes	No
Frank Günther	Hamburg	SSL-erate	Germany	No	Yes	No
Pieter Bolt	TNO	SSL-erate		No	Yes	Yes
Nils Erkamp	TNO			Yes	Yes	Yes
Joram Nauta	TNO			Yes	Half	No
Joyce Zwartkruis	TNO	SSL-erate		No	No	Yes
Flemming Madsen	ELCA			No	No	Yes
Mats Brodén	LLI			No	No	Yes
Caterina Sampol	Gencat	ENIGMA		Yes	Yes	Yes
Anne Wick	Lighting Europe			No	Yes	Yes
Marc Fontoynt	CL Cluster Lumière			Ikea	Yes	Yes
Peter Bracke	KU Leuven			No	Yes	Yes
Jessica Kamps	CICAT cluster		Spain	No	Yes	Yes
Lene H. Hartmeyer	DTU		Denmark	No	Yes	Yes

Alexandre Colombani	LUCI association			No	Yes	No
Anne Bay	Danish Lighting Network			No	No	Yes
Antonella Venza	Luce in Veneto	SSL-erate		Yes	Yes	Yes
Tim Broyd	UCL London			No	Yes	No
Pranciškus Vitta	Vilnius University			Yes	Yes	Yes
Reine Karlsson	Lund University			Yes	Yes	Yes
Lars Montelius	Lund University			No	Yes	No
Håkan Lagerquist	Lund University			Yes	Yes	Yes
Boel Kjellsdotter	Lund University			Yes	Yes	Yes
Gabriele Schliwa	Lund university			Yes	Yes	Yes
Patrik Rydén	Lund University			No	No	Yes
Thomas Lindqvist	Lund University (IIIEE)			No	Yes	No
Andrius Plepys	Lund University (IIIEE)			No	Yes	No
Jessica Luth Richter	Lund University (IIIEE)				Yes	No
Puneet Trehan	IKEA			x		
Bengt Järrehult	SCA				x	
Marika Ivarsson	ÅF					x